Vol. 15 No. 7 July 1961 Published Monthly

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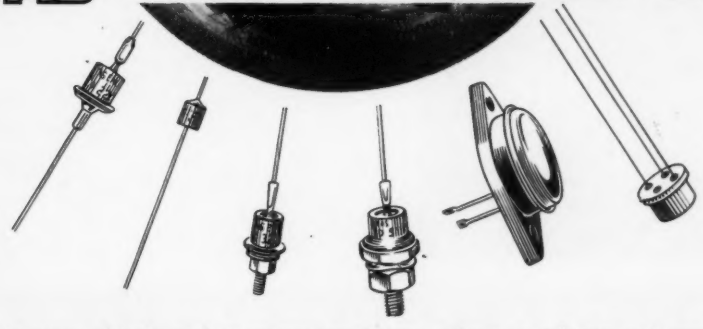
INSTRUMENT PRACTICE

CONTROL SYSTEMS-ELECTRONICS-AUTOMATION

In the world of SEMI-CONDUCTORS

LUCAS see a future in silicon



A wide range of high quality power transistors, voltage regulators and rectifiers for such diverse applications as guided weapons, military and civil aircraft, computers, railway modernisation equipment, automobiles, radio and television. Continuous research, extensive development, and controlled mass-production techniques ensure an ever-increasing flow of devices offering maximum reliability at minimum cost.

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Circle 300 for further information

Circle **301** for further information

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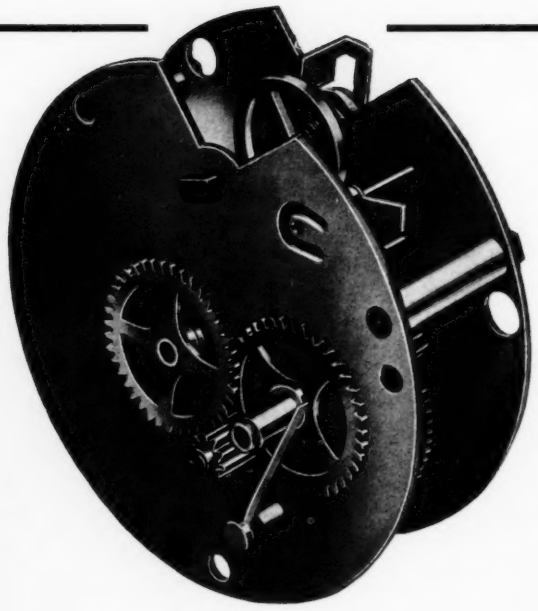
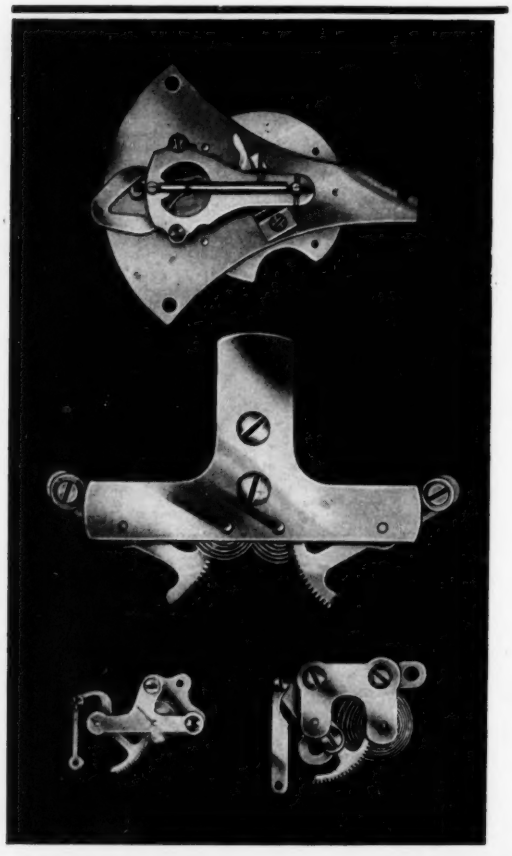
SCIENTIFIC INSTRUMENTS





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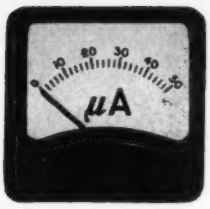

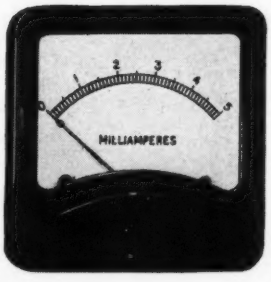

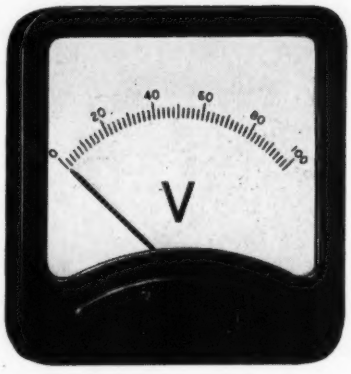

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'ENGLISH ELECTRIC' Instruments

The English Electric Company Limited, English Electric House, Strand, London, W.C.2.

INS. 59

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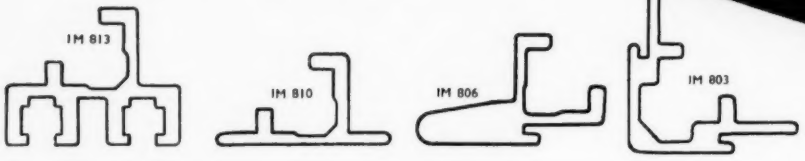
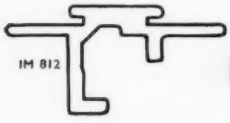
new MINIATURE IMLOK

extends versatile IMLOK range

Send today for full details of this entirely new construction system—the system which permits you to make frameworks in any size from 4¼" cube upwards and with a unique choice in the finished appearance.

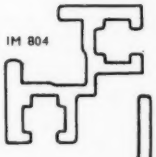


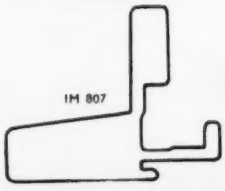


MINIATURE IMLOK can be used for a multitude of purposes including chassis framework, component and instrument housing, display fittings and shelving, showcases, etc.

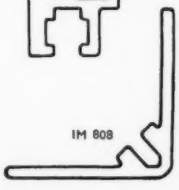
MINIATURE IMLOK uses the established principles of the IMLOK Construction System, with die-cast aluminium connectors and a wide variety of interlocking aluminium extrusions.

MINIATURE IMLOK because of its range of extrusions, allows the widest possible choice of constructional methods and finishes, with extrusions for recessed panels, extrusions for glass and door frame extrusions.





MINIATURE IMLOK is designed for labour-saving simplicity. It is ideal for prototype or small production runs, and is equally suited to large quantity requirements.



MINIATURE IMLOK **economical, versatile, quick and simple!**

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records,
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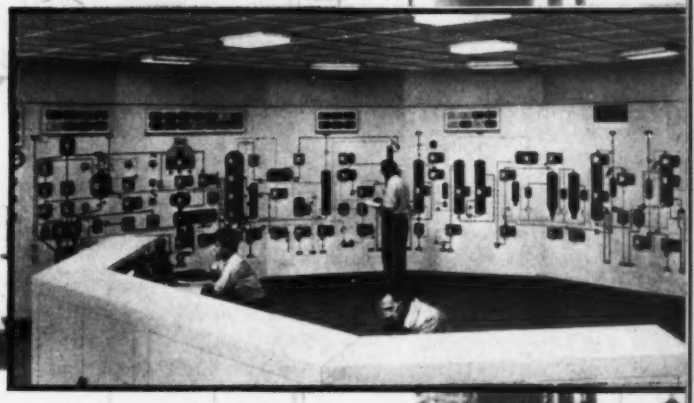

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specify H gold bonded germanium diodes

- ★ **HG5003 is designed to meet CV7127**
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Made in Glenrothes, Scotland, the Hughes range of silicon and germanium diodes are subminiature devices with extremely stable electrical and mechanical characteristics. These diodes are specially designed and constructed to meet the most exacting requirements of military or commercial applications. They are double wire ended and fusion-sealed in a subminiature one-piece glass envelope to ensure complete isolation of the active elements from damage or contamination. The small size, combined with rigidity of construction and small mass of the elements, enable them to successfully withstand physical shock and vibration.

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Type No.	Continuous ratings 25°C		Characteristics 25°C	
	Max. Reverse Volts	Max. Forward Current	Max. Volts Drop	Max. Reverse Current
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HG5002	70	80 mA	.8 v @ 100mA	5μA @—50V
HG5003	100	80 mA	.8 v @ 100mA	25μA @—50V
HG5004	70	80 mA	.8 v @ 100mA	25μA @—50V
HG5005	100	80 mA	.8 v @ 100mA	50μA @—50V
HG5006	70	80 mA	.8 v @ 100mA	50μA @—50V
HG5007	40	80 mA	.8 v @ 100mA	5μA @—30V
HG5008	40	80 mA	.8 v @ 100mA	25μA @—30V
HG5009	40	80 mA	.8 v @ 100mA	50μA @—30V

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Circle **307** for further information

A WORLD OF VIBRATION

Vibration technology is a comparatively new development in the field of environmental engineering. Its applications in measuring metallurgical stresses and strains, in simulating fatigue to destruction point, are fairly well-known, but even the present scope is far wider than these. The potential is immense to a degree which possibly outreaches that of any other applied science. It is even possible that there is much to be rediscovered, for the histories and mythologies of ancient civilizations abound in references to physical motion achieved through sound vibrations. The destruction of the walls of Jericho is an example; and it has been suggested that the Pyramids' vast masonry was elevated by similar means. But fascinating and perhaps revealing as that line of inquiry may be, this report will deal principally with the immediately practical uses of vibration testing.

From eyes to motor cars is an apt and related part of the applications range. Taking the first and uncomfortably picturesque example, an incidence of severe headaches and impaired vision suffered by transport drivers led to tests with vibration equipment. These showed that through vibration on certain road surfaces, the drivers' eyes were being literally bounced back and forth in their sockets.

MOTOR VEHICLE INDUSTRY

Car bodies and their attachments are subject to mechanical and other vibrations transmitted through suspension systems. What with wear and tear and varying concern for maintenance, the noises which can result are an age-old problem at the service station. The drumming heard by the owner 'under the back seat somewhere' is usually non-existent in normal workshop testing; out on the road it's audible but locating it is a tedious and uneconomic guessing game.

Yet further complications arise out of the fact that the vibration source may be far removed from the apparently offending component or structure.

We have a compact generator/oscillator/power amplifier combination by which all the running vibrations can be simulated *in the workshop* and the noise source accurately and quickly located. Similar equipment is used by car manufacturers so that vibrations can be compensated or designed out.

ROAD CONSTRUCTION

Roads, too, can be investigated with vibration equipment. An applied vibration is picked up at a distance, on an oscilloscope. The signal time and strength factors vary according to the nature and thickness of the surface and subgrade materials. By these readings it can be determined whether or not the construction is according to specification. Periodic tests will reveal the extent of any deterioration. In research, the behaviour of roads under various traffic conditions can be established and the information used in framing specifications for new roadworks.

AIRCRAFT INDUSTRY

In the aircraft industry, vibration testing has long been a vitally important technique. Bearing in mind the possible outcome of the failure of quite small components, vibration problems in land vehicles and structures pale into comparative insignificance. Goodmans equipment is widely used to test dynamic models . . . even whole aircraft . . . and on the multiplicity of instruments and electronic apparatus.

The tremendous power and complexity of rocket-propelled vehicles set still more-exacting requirements and for these Goodmans are producing special generators.

OTHER APPLICATIONS

The miscellany of these is far too extensive to catalogue here, but the following will serve to demonstrate the scope.

In fatigue testing, vibration generators provide wide range and prolonged consistency.

Chemical and bio-chemical research are served by our smallest generator, the V47, in mixing, emulsifying and the measurement of interface potentials. It has been used also to simulate nerve signals and to assess vibration effect on living tissue. Experiments show that physical vibration and 'white noise' have anaesthetic properties.

Vibration equipment is used in the rubber, plastic and textile industries, as an aid in establishing the materials' mechanical properties.

Experiments in the machine tool industry have shown that small and carefully controlled vibrations can, in fact, improve stock removal, surface finish and minimize the effect of certain operations upon molecular structure.

This is inherently a world of movement. Everything vibrates within itself and often as an entity. These forces can be observed, reproduced, supplemented. There must therefore be many functions for our vibration equipment which even we can only guess at . . . and even more as yet unthought of. Name your problem; consider what may be done better, faster, more economically . . . what may be done perhaps for the first time, with the help of vibration equipment. It's more than likely that the means to the end is ready-made.

Goodmans electro-mechanical vibration generators, the largest range in Europe, comprise:

TYPE	*PEAK THRUST*
V47	2 lb
390A	17 lb
790	35 lb
8/600 Mk.II	300 lb
VG108 Mk.II	5,300 lb
VG109 Mk.III	18,000 lb

There is available a corresponding range of oscillators and power amplifiers

GOODMANS
the vibration specialists

GOODMANS INDUSTRIES LTD. AXIOM WORKS, WEMBLEY, MIDDLESEX ENGLAND Wembley 1200 (8 lines) Cables: Goodaxiom, Wembley, England

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PILOT PRACTICALITIES No. 5

A series to acquaint engineers with the very practical advantages of PILOT plug gauges which ***reduce*** *gauging costs.*

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It will be appreciated that a plug gauge resembles a watch....two penny-worth of material and five pounds' worth of skill. Because of this obvious fact Pilot buy the very best steel it is possible to procure, and if a superior specification could be obtained at twice the price in order to improve the performance and enhance still further the reputation of PILOT we would use it. All steel in Pilot gauges, bars or forgings, is hammered and rolled to ensure maximum results, but this of course is much more costly than drawn rod. It is a fact that a 'cheap' gauge without finish hardness, 'top limit' and accuracy, and made from nondescript material is a very poor investment in the end.

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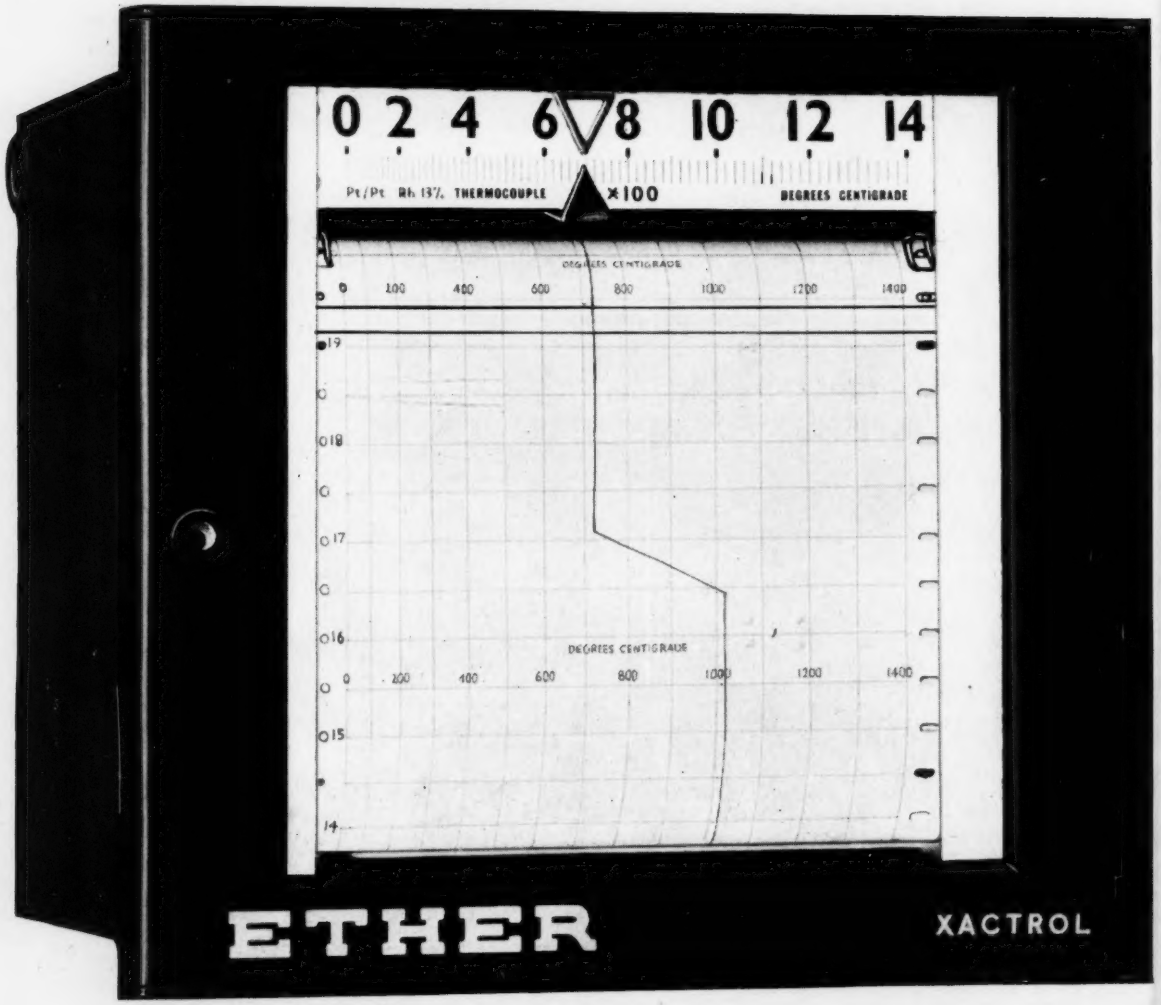


–for indicating, recording and co

TEMPERATURE · SPEED · FLOW · PRESSURE · STRAIN · RESISTANCE · CONDUCTIVITY · pH

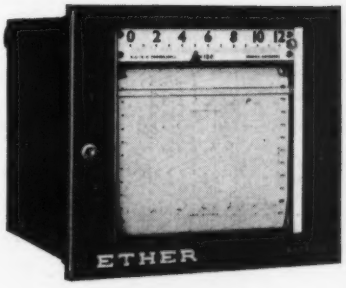
POTENTIOMETERS

PATENTS APPLIED FOR

SERIES 2000 *(illustrated opposite)*
Single-point Potentiometer Recording Controllers

6" calibrated scale * Standard ranges: 2mV-100mV span
Pen speed: 1, 2 or 4 secs. across chart * Chart life: 1 month at 1 inch per hour.

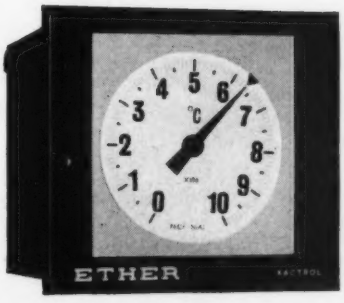
Available with (i) Two-position on/off control (ii) Anticipatory control (iii) Proportioning (electrical) control (iv) Three-position control (v) Programme control (vi) Proportioning (motorised) control



SERIES 2050
Multi-point Potentiometer Recorders

6" calibrated scale * Balancing motor totally de-energised throughout printing and indexing cycles *
Standard ranges: 5mV-100mV span *
Pen speed: 2 secs. across chart * Printing speed: 6 secs. per point

Available with (i) Two-point record (ii) Three-point record (iii) Six-point record.



SERIES 2500
Single-point Potentiometer Indicating Controllers

18" calibrated scale * Standard ranges: 5mV-100mV span * Response speed: 2 secs. across chart * Bold easy-to-read scale and pointer.

Available with (i) Two-position on/off control (ii) Anticipatory control (iii) Proportioning (electrical) control (iv) Three-position control (v) Programme control (vi) Proportioning (motorised) control

Illustrated leaflets of all 'Xactrol' Potentiometers from: ETHER LTD.
TYBURN ROAD, ERDINGTON, BIRMINGHAM, 24 :: East 0276-8
CAXTON WAY, STEVENAGE, HERTS :: Stevenage 2110-7

FROM **£126** DELIVERED

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FOUR DECADES of PROFITABLE ASSOCIATION between HOFFMANN & SPERRY

Assembling the Gyro Rotor for a C.L.2 Gyrosyn® Compass. Note the dustproof dispensers containing the bearings.

HOFFMANN . . . THE PEOPLE INTERESTED IN SPERRY STANDARDS

Navigators of ships and aircraft, each vitally concerned to achieve the safe and timely arrival of their craft, put their faith in Sperry compasses and instrumentation.

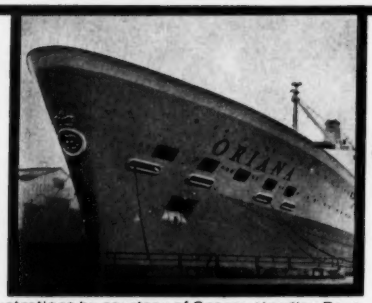
HOFFMANN BEARINGS, fitted extensively to Sperry instruments, help them to function consistently and accurately to Sperry standards.

GLOBAL ACCURACY

Like many other well-known civil and military aircraft, the Handley Page Dart Herald Branch Liners ordered initially by B.E.A. and Jersey Airlines, rely extensively on Sperry equipment for automatic flight control and instrumentation, the latter including Gyro horizons and Gyrosyn®compasses employing Hoffmann Bearings. The trouble-free performance of these instruments was demonstrated in the most practical manner by the prototype and first production aircraft respectively in four recent demonstration tours to India, South America, Australasia and West Africa. Sperry Gyrosyn Compasses have, for many years, depended on Hoffmann Bearings for long life, accuracy and reliability.

35,000,000,000 REVS

The record of Port Line's M.V. Port Fairy, 8,406 tons, includes 65 round voyages between U.K. and New Zealand in 32 years, guided by a Sperry Mark VIII Gyro Compass. Since 1943 the 51 lb. weight of the compass rotor has spun steadily at 6,000 r.p.m. upon its HOFFMANN BEARINGS and to date has completed more than 35,000,000,000 revolutions. It is still spinning, trouble free, and accurate upon those same HOFFMANN BEARINGS.



MAIDEN VOYAGE

T.S.S. Oriana, P & O – Orient Lines 42,500 tons luxury liner, sailed on her maiden voyage to Australia, New Zealand, and the Pacific coast of U.S.A., following a course set by a Sperry Mark XIV Gyro Compass. This Compass provides the heading reference for the gyro-hydraulic automatic steering-control, the direction-finding system, radar installations, and several compass repeaters. These include an enlarged-scale steering repeater, two bearing repeaters on the Bridge wings, and a repeater in the steering-gear flat. Three out of four of the World's merchant ships are set upon their courses by Sperry Gyro Compasses, the majority of which employ Hoffmann Bearings.

Illustrations by courtesy of Sperry, Handley Page, Port Line and P & O – Orient Lines.

Manufacturers of ***BALL AND ROLLER BEARINGS***

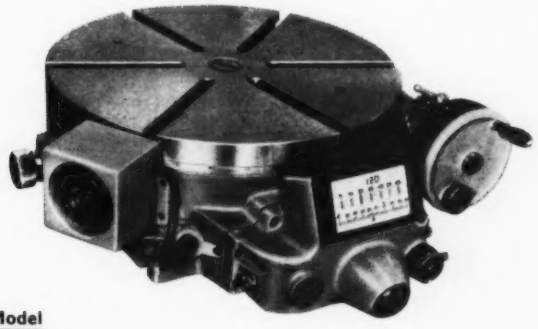
HOFFMANN

THE HOFFMANN MANUFACTURING CO. LTD., CHELMSFORD, ESSEX. Telephone: Chelmsford 3151. Telex No. 1951

Circle 311
for further information

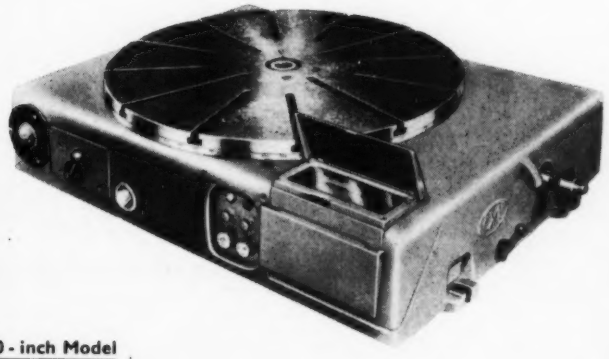
10 - inch Model

Platen diameter	10"
Scale reading	30 secs. of arc
Microscope magnification	70 x
Overall size	15¼" x 13" x 5"



16 - inch Model

Platen diameter	16"
Scale reading	1 sec. of arc or 10 secs. of arc
Overall size	22" x 20½" x 5¾"



30 - inch Model

Platen diameter	30"
Scale reading	1 sec. of arc
Overall size	40" x 32" x 9¾"

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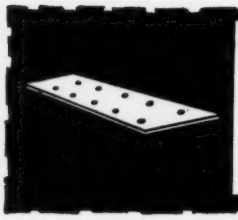
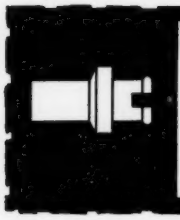
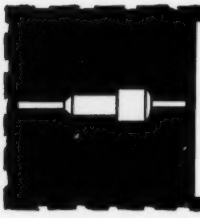


TERMINAL BOARDS



LUGS



MOULDED INSULATORS

CHASSIS FURNISHINGS

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Harwin *make* components—*specialise* in components. Lugs, moulded insulators, terminal boards and chassis furnishings. 'Off-the-shelf' or to special design.
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STRAWS IN THE WIND?

...Yes, indeed, a nuclear precedent for industry

The photograph shows a close-up of one of the seal glands on the pressure vessel wall and biological shield at Berkeley Power Station through which pass some of the 982 "Pyrotenax" thermocouple cables.

The almost automatic choice of "Pyrotenax" thermocouples and compensating cables for the requirements of nuclear power set a precedent for industry—and one which has been quickly followed. Industrial applications are increasing every month.

The temperature range is sub-zero to 1100°C., sizes to .25" down to .040", with many alternatives of sheath and conductor metals.

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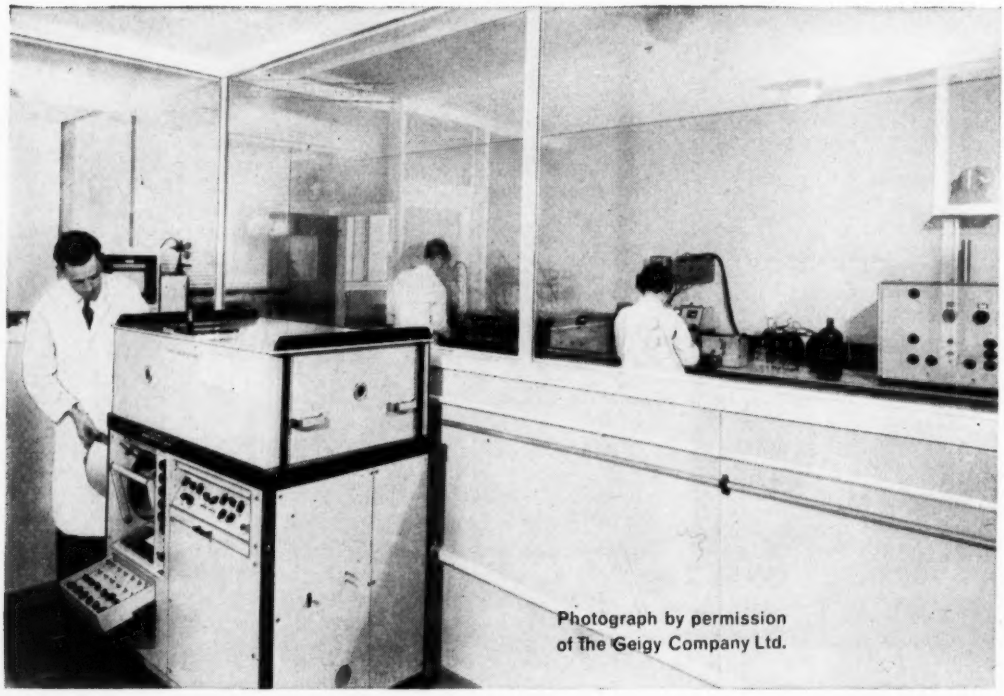

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U2

This recording is typical of line voltage conditions in an industrial establishment where voltage variation is a problem.

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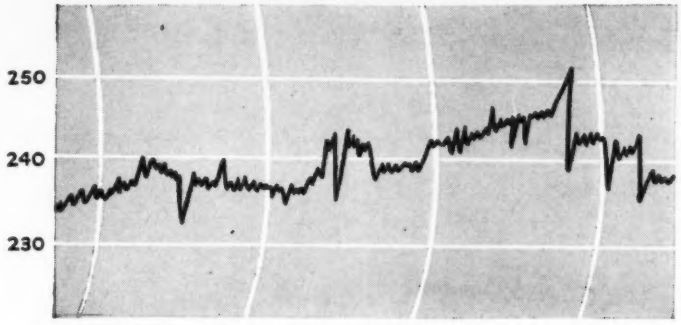
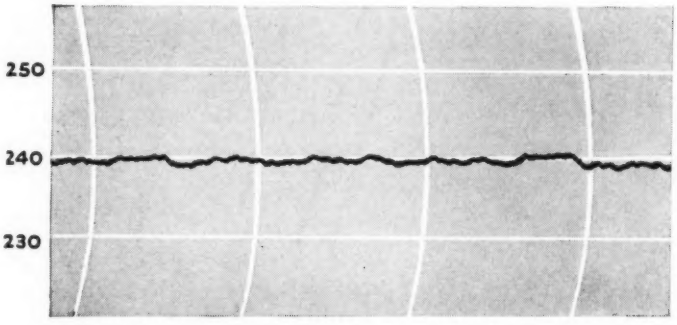
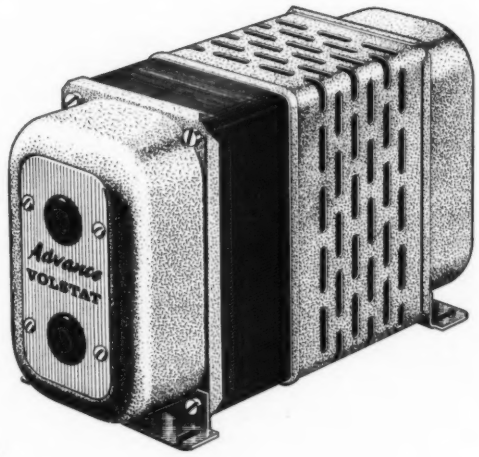


FLUCTUATING VOLTAGE



becomes constant with a

VOLSTAT



A VOLSTAT is the answer to many voltage fluctuation problems. In most cases, a standard type is all that is required—but there are occasions when a special design may be necessary. Either way, an 'Advance' Technical Representative will be pleased to investigate your own particular problems, and recommend a VOLSTAT best suited to your needs. VOLSTAT stands for a complete range of Constant Voltage Transformers produced by 'Advance'—the leading authority on voltage stabilization. Full details in Folder D63 available on request.

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EXHIBITING at 1961 Electronics, Instruments and Components EXHIBITION · Manchester July 6-12

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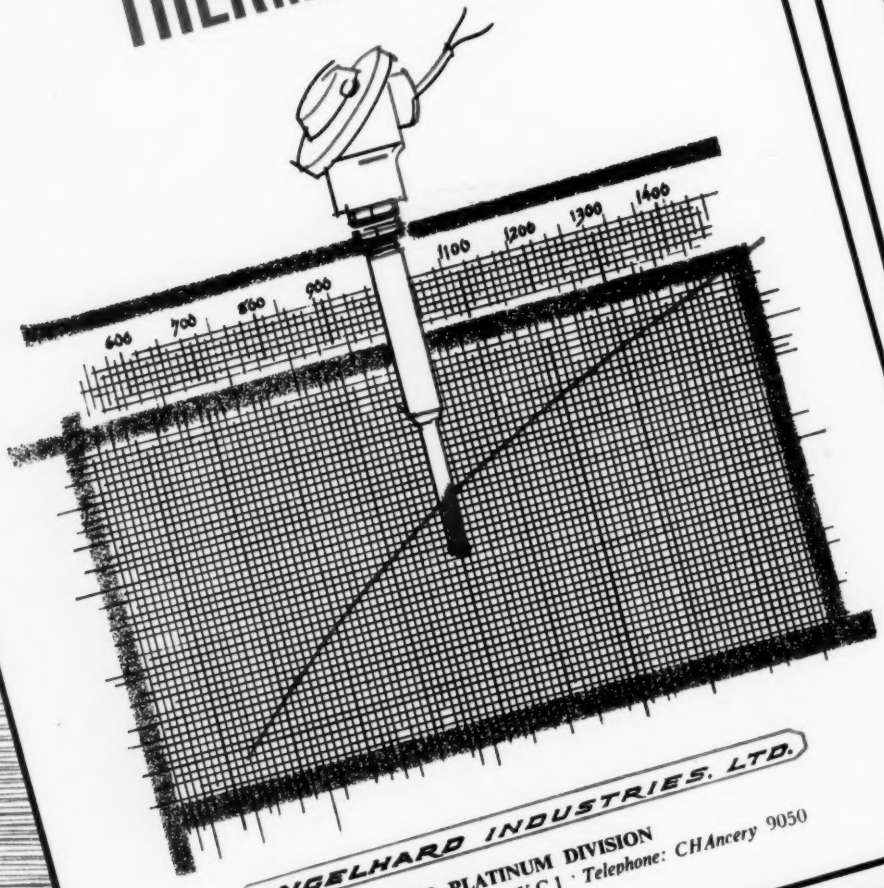
Write for this informative booklet

which gives details of the many thermocouple combinations available from Engelhard Industries together with graphs illustrating the temperature—e.m.f. relationship of each couple, and calibration tables for the most commonly used combinations.

PRECIOUS METAL THERMOCOUPLES

CALIBRATION TABLES



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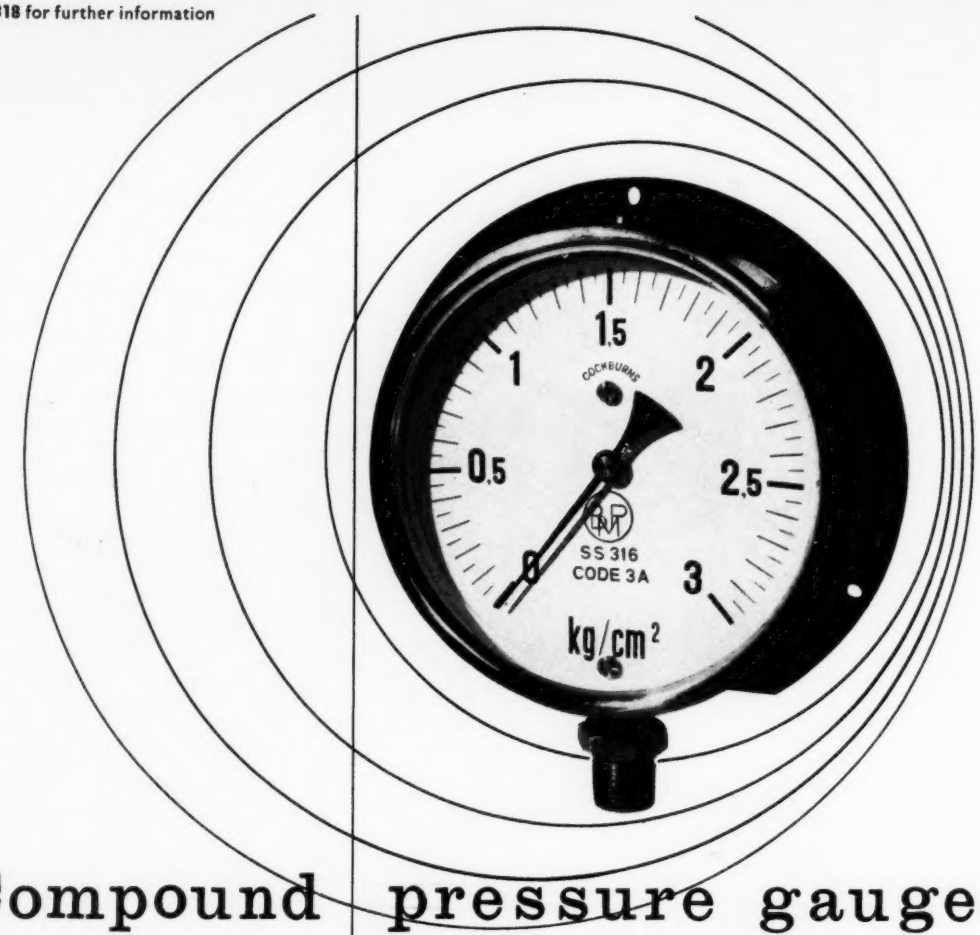

Compound pressure gauges

with zero adjustment

These Bourdon-tube gauges, now being supplied by Cockburns, are exceptionally accurate, robust, reliable and keenly priced. Their design has been proved by extensive use in chemical, petroleum, refrigeration and marine industries throughout the world.

The preliminary-pressure and fluctuation-shock inaccuracies common to gauges with needle-stops are completely obviated in the compound design. The zero adjustment ensures complete accuracy over the whole scale, at all times, without recalibration.

Standard gauges are available for all pressures, graduated in lbs/in² or kg/cm². A super quality gauge with heavy duty rotary movement designed in association with leading Oil Engineers is also available. Gauges with special corrosion or wear-resistant internals can be supplied.

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DIAL THERMOMETERS
mercury in steel, vertical and angled models.

AUTOMATIC SAMPLING UNITS
for regular draw-off of liquid samples.

TEMPERATURE INDICATING CONTROLLERS
for oil tank heating systems.

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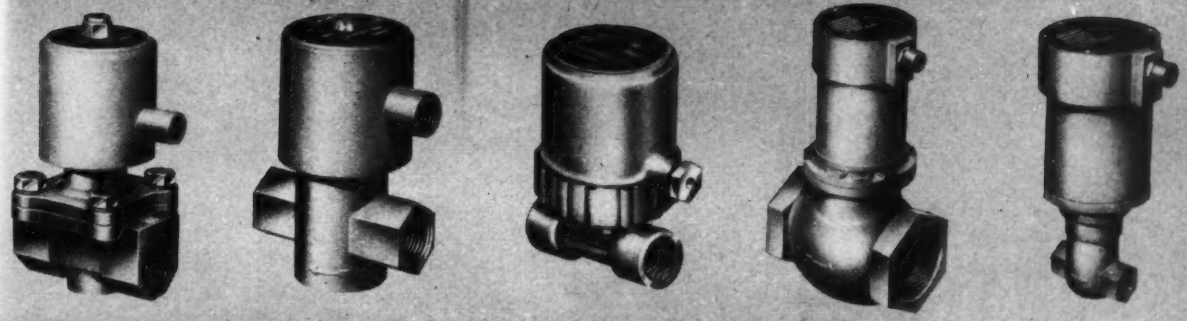
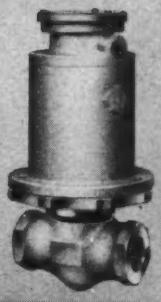
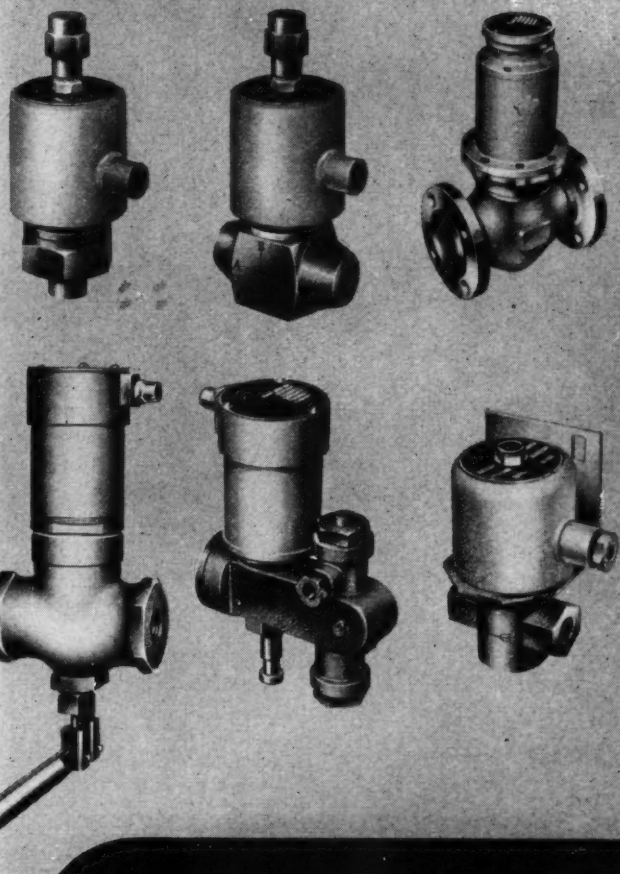


For any type of SOLENOID VALVE — *whatever your need*





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If the solenoid valves you require are not included in our comprehensive standard ranges, our Design Engineers will gladly develop special types to suit your requirements. Whatever your need, send us your enquiries for prompt attention.

This solenoid valve, made entirely of stainless steel, was custom-built to control high-pressure radioactive material at a temperature of 150°F for a nuclear energy application.

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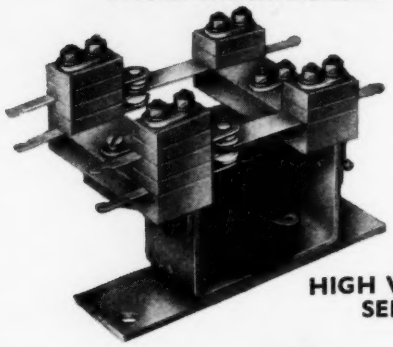
ELECTRO METHODS LTD



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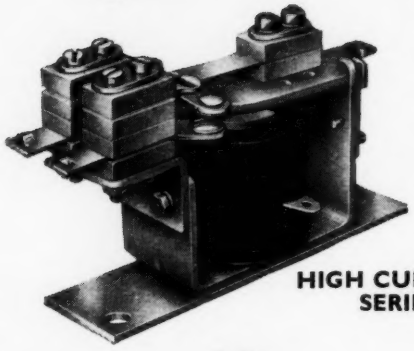

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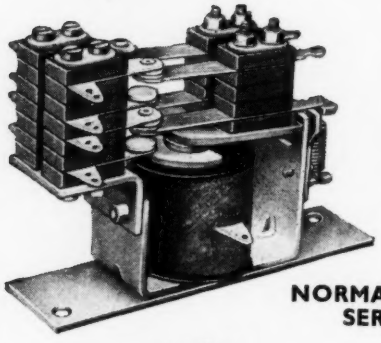

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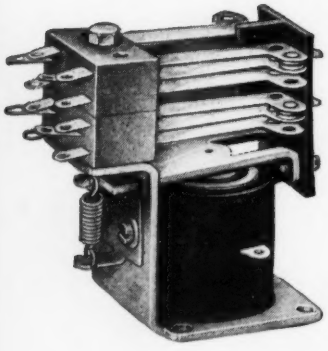

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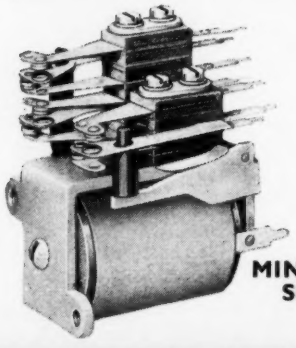

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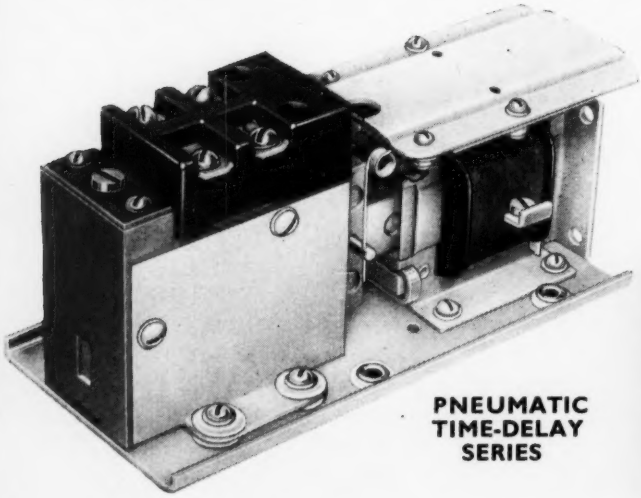

PNEUMATIC TIME-DELAY SERIES

PRECISION RELAYS

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Telephone: Stevenage 2110-7

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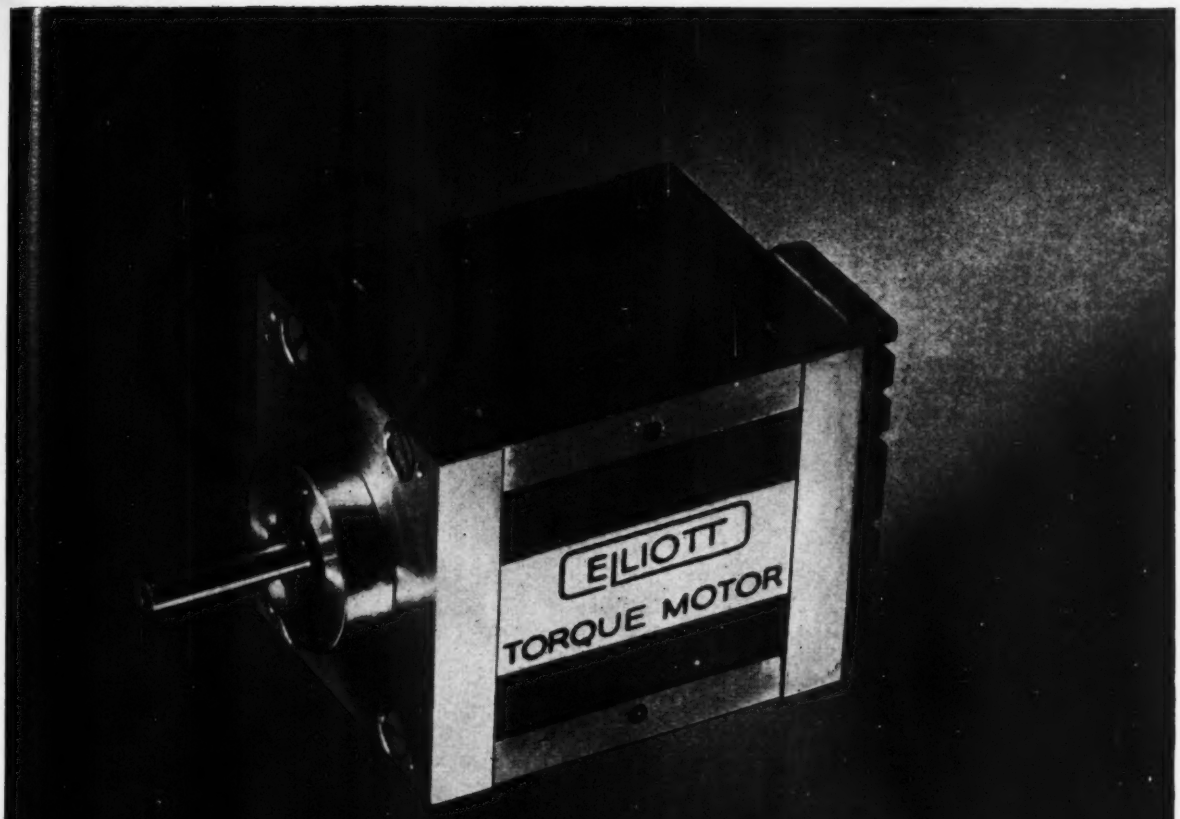

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Introducing the entirely new **Elliott Type 130 Torquemotor** with an outstanding range of performance characteristics. Light, compact, high torque output with good linearity, low hysteresis, excellent frequency response, low inertia and high stiffness.

Supplied with integral Velocity or Displacement Pick Offs if required.

This is the most advanced D.C. operated electro-mechanical transducer on the market.

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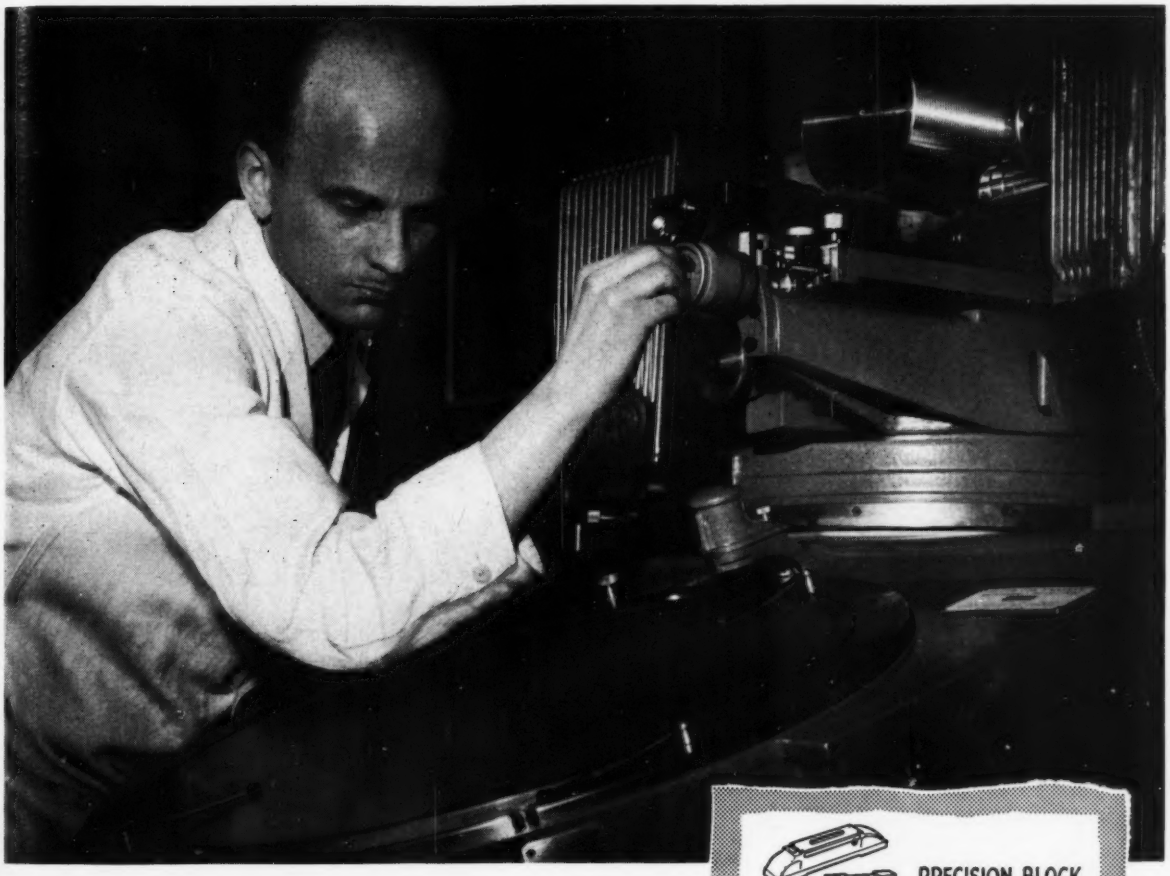

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Send for a copy of our general measuring catalogue, over 150 instruments illustrated.

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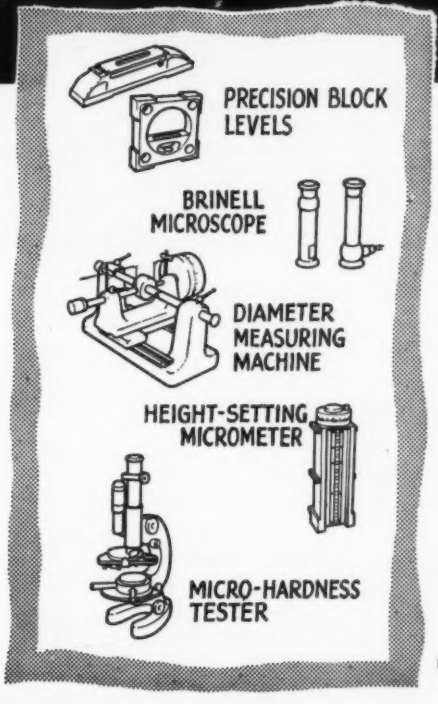

D.637

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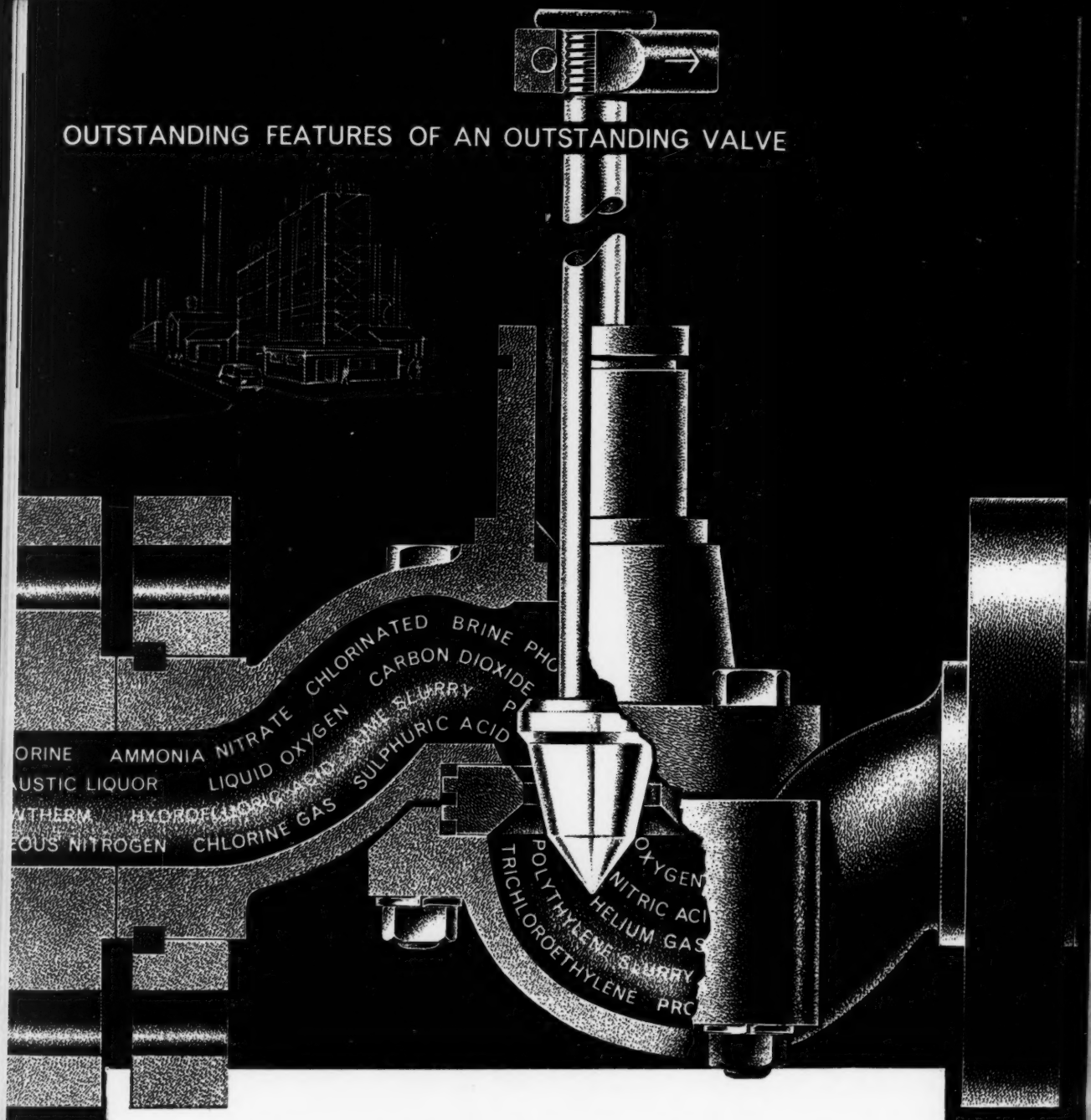

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AUDCO ANNIN DIVISION

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ELECTRONIC INSTRUMENTATION PIONEERED AND PERFECTED BY BURNDEPT

Background: an Esso photograph

CONTROL...minus the HUMAN FACTOR SPOTLIGHT ON PROXIMITY SWITCH BE.238

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NUCLEONICS

Operating upon changes in capacitance as low as 0·05 pf, this Burndept Proximity Switch provides extremely sensitive control of temperature, level, counting, process initiation and innumerable other applications. The sensing probe will detect any object in its vicinity without physical contact. Given a sufficient change in contour, it will even sense objects touching each other, requiring only a probe on one side of a conveyor belt, thus overcoming an inherent drawback of photo-electric methods. Furthermore, it will provide accurate level control of powders, fluids or granules, either electrically conducting or non-conducting.

The switch will operate continuously under adverse industrial conditions and is not affected by dust, moisture or vibration. If necessary, it can be supplied in a flame or explosion proof enclosure. A wide range of standard sensing probes is available, and probes can be designed to suit special requirements. A 6–ft low capacity, high stability co-axial cable is provided. There are two alternative terminations to suit particular probes, and armoured versions of both types are available. A Matching Unit can be used, allowing lead lengths up to 58 ft. between sensing probe and main unit.

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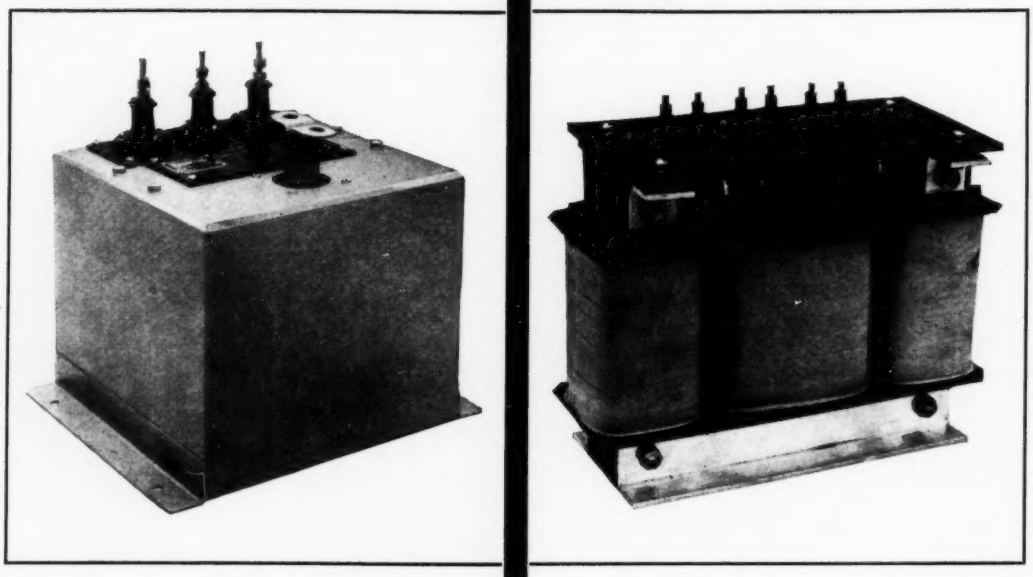
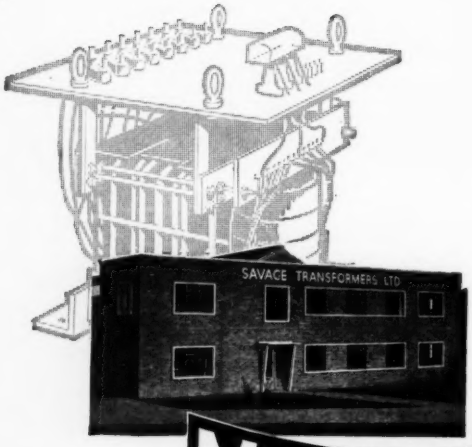
SAVAGE MASSICORE

TRANSFORMERS | TRANSDUCTORS



Robust • long lasting • excellent performance



No matter what the application, Savage Massicore Components are specially designed for the job and built to last.

Illustrated above are:-

Left — a push pull, class B output transformer designed to deliver 2500 watts into a very low impedance transducer, at from 10 K/c to 100 K/c.

Right — one of a large family of Saturable Reactors, used to control the current delivered by the supply mains to a heating load.

Maybe our experience could provide the answer to your problem — We should be happy to co-operate in its solution.

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MASSICORE SAVAGE

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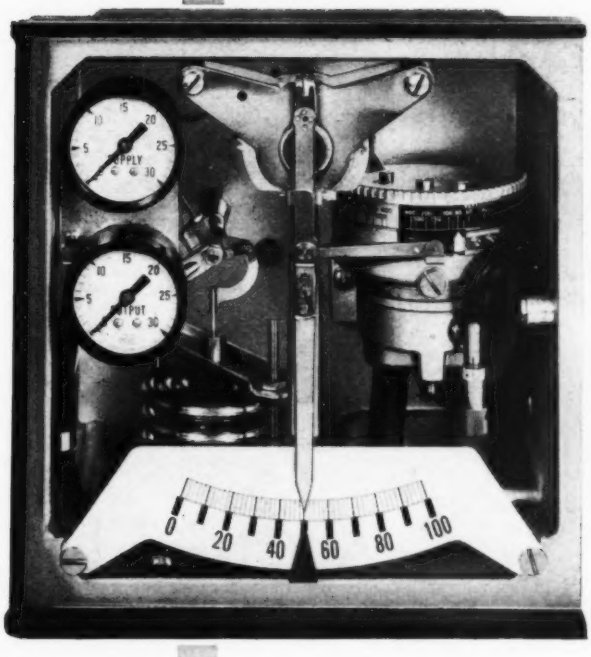
New advanced design indicating pneumatic controller



BRISTOL'S

SERIES 624

Highlight of this new indicating pneumatic controller is the new Bristol advanced design control unit.

Summary of A/D Controller features

It can be used with the wide range of Bristol's precision measuring elements for pressure, temperature, and flow.

PERFORMANCE
Excellent frequency response, far better than most comparable control units.

EASY MAINTENANCE & INTERCHANGEABILITY
Plug-in units, simple to work and calibrate.

LONG LIFE
Type 316 stainless steel parts. Rugged construction.

STABILITY
Single-capacity systems.

AMBIENT COMPENSATION
Wide-range temperature and pressure compensation, so that control unit does not shift its set-point.

SPECIFICATIONS

MODEL No: 624
CASE: Cast aluminium 8" x 8" x 5".

MEASUREMENTS:
Pressure – full vacuum to 10,000 psi.
Temperature – minus 100°F to +1000°F.
Flow and level – wide range with both mercury and dry type meter bodies.

CONTROL:
Proportional with 1 to 400% proportional band, direct or reverse action (Model 624B).
Proportional-plus-reset control unit. Proportional band adjustable 0-400%. Reset rate adjustable from less than 0.1 to more than 100 repeats per minute.
Proportional-plus-derivative control unit. Proportional band is adjustable 0-400%. Derivative time is from 0-10 minutes.

PILOT VALVE:
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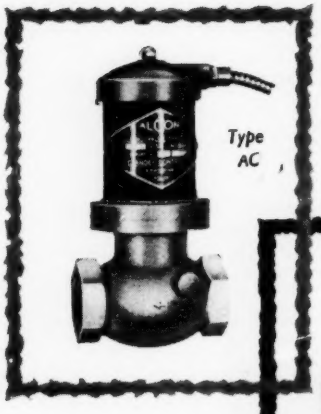
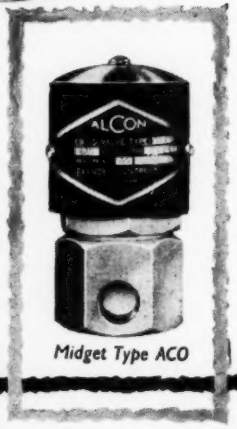
MIDGET TYPE ACO. Used all over the world for control of domestic oil burning. Sizes up to $\frac{3}{8}$ in. B.S.P., with self-contained by-pass if required.

TYPE AC. Normally closed, opens when electrically energised. Sizes from $1\frac{1}{2}$ in. to 3 in. bore to control gas, air, oil, etc.

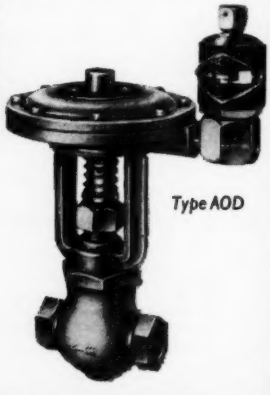
TYPE ACP. Servo Operated Piston Type. Will handle liquids and gases at high pressure with a small expenditure of electrical power.

TYPE AOD. Heavy duty air operated units, individually designed for control applications beyond capabilities of Solenoid types. For pressures up to 1,500 p.s.i. Sizes $\frac{1}{4}$ in. B.S.P. - 8 in. bore.





Midget Type ACO



Type AOD

ALCON

ALEXANDER CONTROLS LTD

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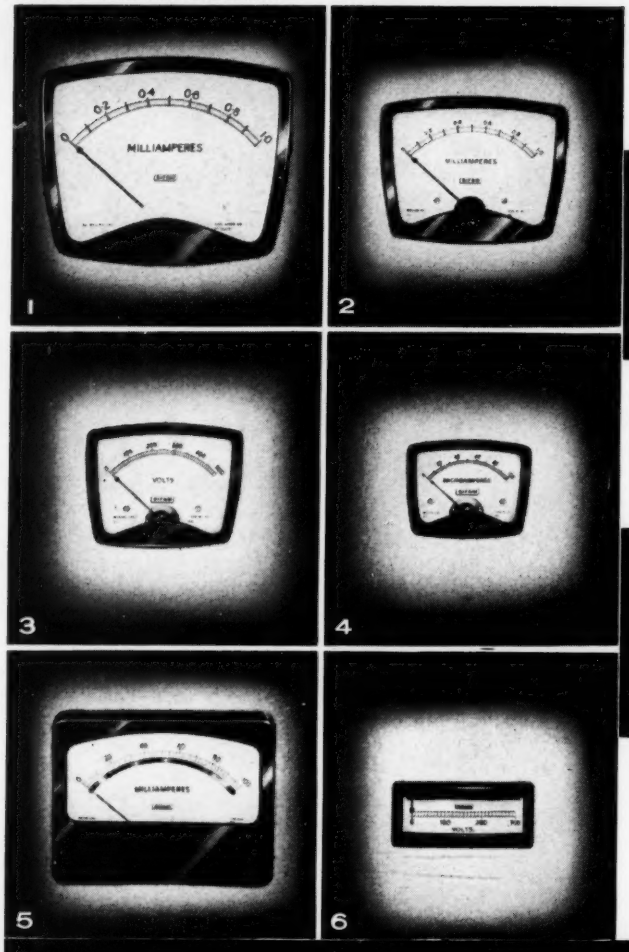

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STEP BY STEP...

It is not always essential—or convenient—to
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all at once. It is often preferable to convert
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Automation Step-by-Step.

A probe for fluid level control

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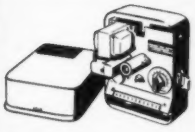

The TRU3 Timer with cover removed showing setting control on right

A viewing head for burner control

and there are many more.

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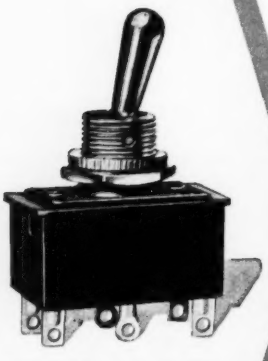
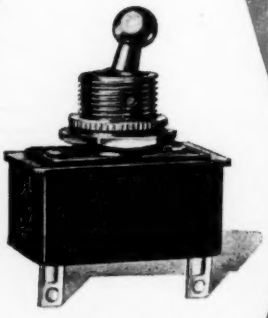
Switches

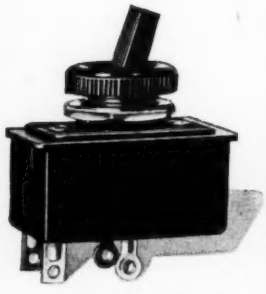
For Instrument and Electronic Applications



✲ Cat. No. 81058-BT Double Pole Double Throw 2 Position Lever Type Back Connecting Lugs



Cat. No. 81046 Single Pole Single Throw. 2 Position Lever Type. Back Connecting Lugs



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The exacting conditions of service demanded by modern techniques in electronic equipment and instrument development are fully matched by this new range of ARROW bakelite enclosed switches.

Their main characteristic is the maintenance of low contact resistance after considerable life.

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✲ BIASED ACTION SUPPLIED FOR ALL CIRCUITS.
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A22

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INTERNAL MAGNET SYSTEMS

The internal magnet system was developed originally about 30 years ago but it is only in recent years that this method has been used on a large scale. The basic principle is simple; instead of a coil working around an iron concentrator in the pole tunnel of a large magnet assembly, the concentrator is replaced by a cylindrical magnet with iron pole shoes attached to give a linear distribution of flux. The coil then swings between the magnet assembly and an outer iron ring, which provides the return circuit and a shield against stray fields.

Usually, the pole shoes are either fixed by an adhesive or by solder or are dovetailed into the periphery of the magnet. All these methods however, introduce gaps of high reluctance in the circuit and difficulties can also arise in attaching the shoes accurately and firmly in position.

THE 'SINCOMAX' TECHNIQUE

Powder Metallurgy and the "Sincomax" technique, developed by Murex Limited, applied to the manufacture of this type of assembly, have now made possible magnet units of reliable and consistent performance. The problem of attaching the iron shoes has been completely overcome by the application of the "Sincomax" technique, which enables magnet material and iron powder to be pressed and subsequently furnaced as one piece to form a single composite unit of high bond strength having a definite line of demarcation between the two materials.

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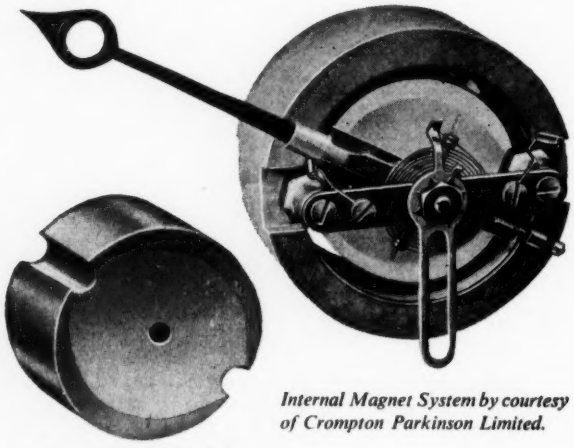

Internal Magnet System by courtesy of Crompton Parkinson Limited.

ACTUAL SIZE OF MAGNET

Murex Limited have many years experience in the manufacture of magnets by the Powder Metallurgy technique and qualified technical staff are available to advise on magnet design and performance.

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London Sales Office: Central House, Upper Woburn Place, W.C.1. *Tel. EUSton 8265*

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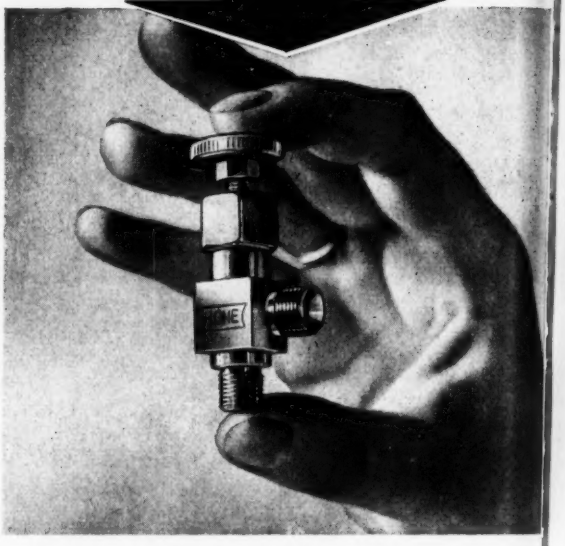

★ ONLY 2¼" LONG OVERALL
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Manufacturers of Test Equipment for the Petroleum Industry

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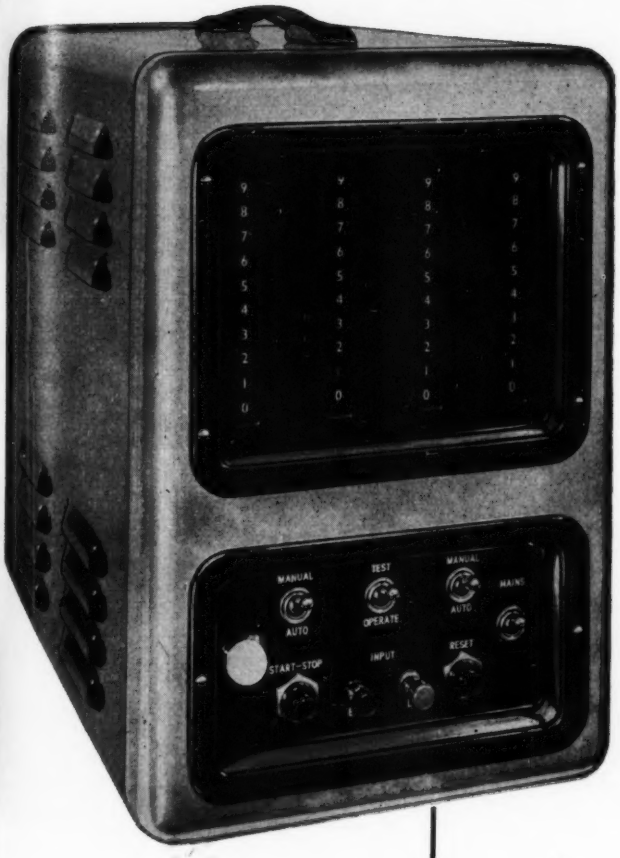

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Frequency measurement
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Period and time interval measurement
10μSec — 1 second

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Regular or random pulse counting and totalising

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Compact and portable, the SA20 combines high performance and accuracy with versatility and simplicity in operation.

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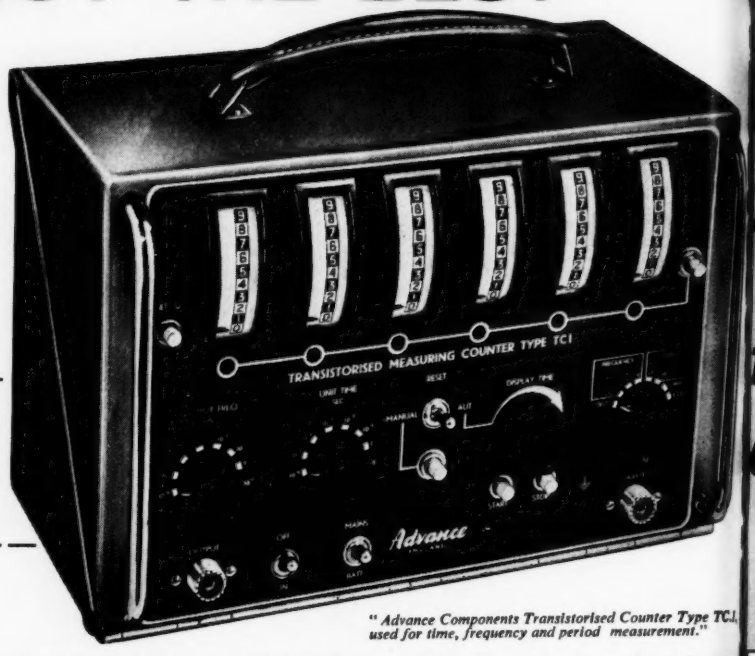
There can be no finer advertisement for your equipment than the name "Weston" on the meters installed



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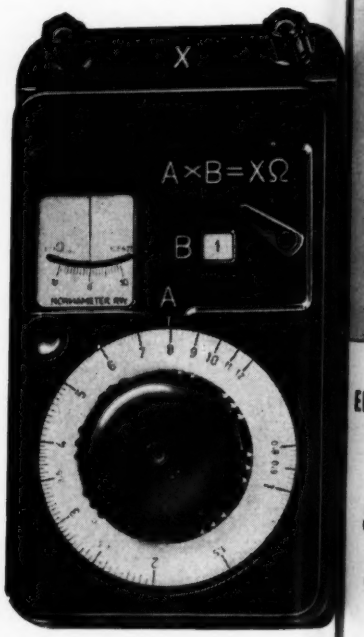

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HAMPTON ROAD · CROYDON · SURREY Telephone THORNTON HEATH 4025 & 4094

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protects flame-traps

from the dangers of blow-back flames

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ETHER FLAME-TRAP ANCILLARY UNIT

Patent applied for

TYPE 350

This new safeguard, the ETHER Flame-Trap Ancillary Unit, Type 350, will be invaluable in industries where pre-aerated gas or pre-mixed gases are used. At present, a flame-trap is normally provided to arrest the flame temporarily when a blow-back occurs, but unless it is noticed, the flame will ultimately burn through the flame-trap.

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AT NEW LOW COST

* Rated speed-up to 1000 Counts per minute
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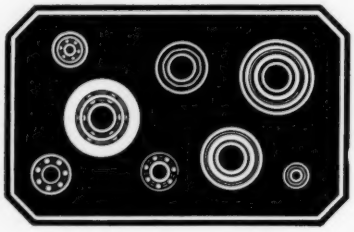

The bearings illustrated are actual size.

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ranging in size from 1.5 mm. o.d. upwards.
Also super-precision and sealed ball bearings in several sizes.

FULL PARTICULARS AND SIZES ARE AVAILABLE ON APPLICATION

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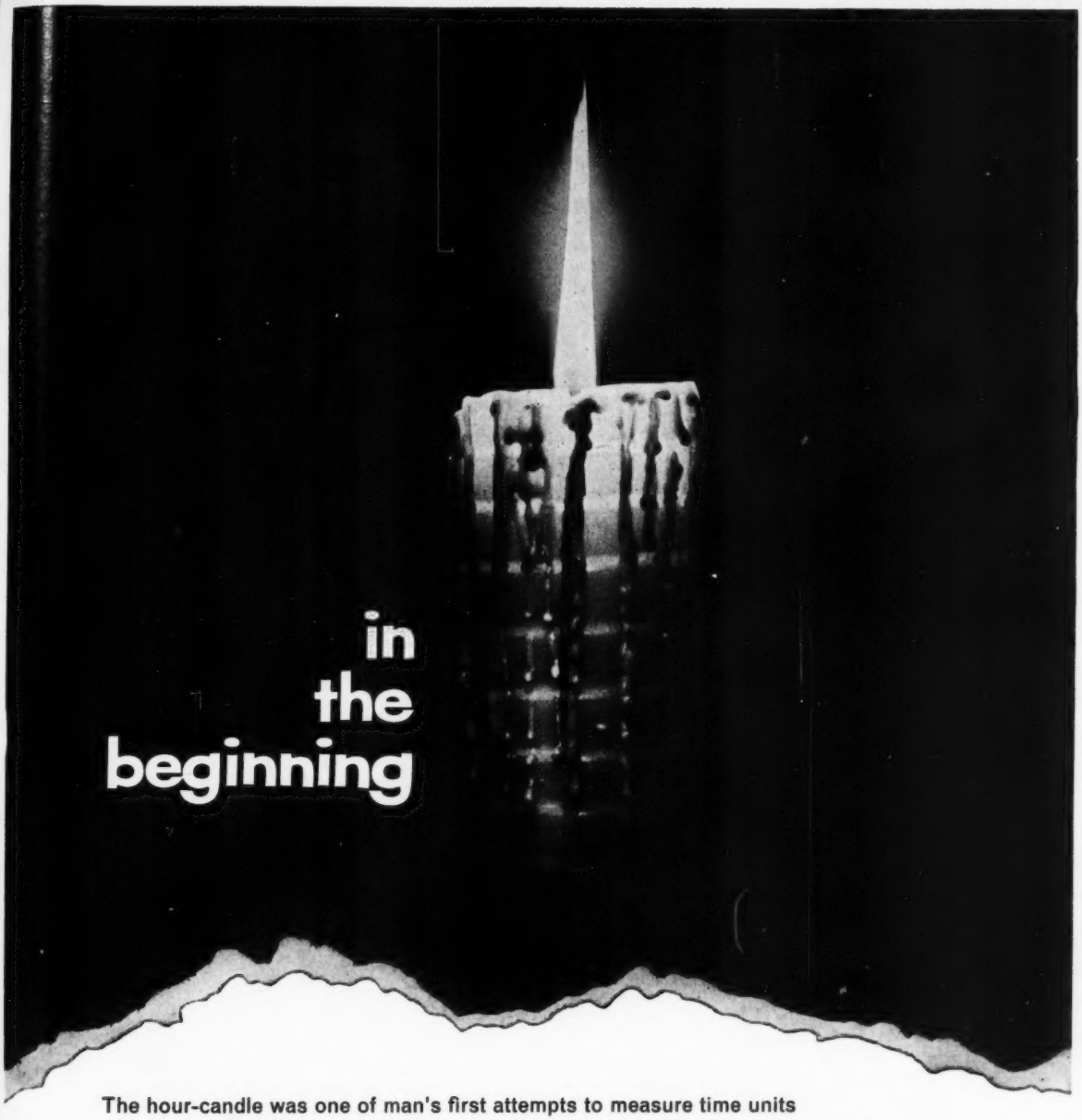

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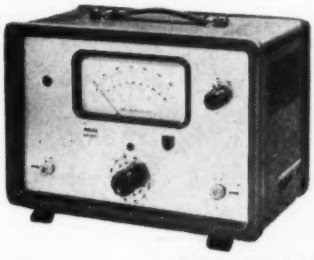

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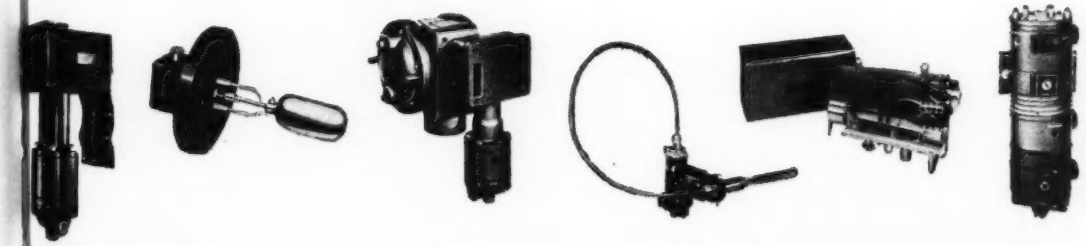

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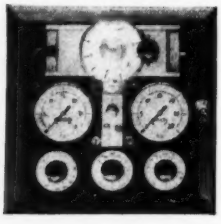

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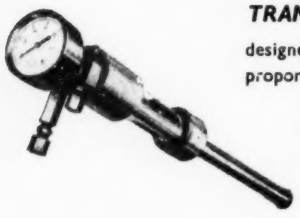

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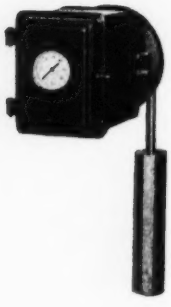
designed to produce an adjustable proportional air pressure signal of 3/15 lb. per sq. in. (gauge) corresponding to the measured temperature. Range −100°F to +1250°F with an adjustable span of 180°F.



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to maintain a required level in open or closed containers. In the case of closed containers, they may be pressurised to 900 lb. per sq. in.

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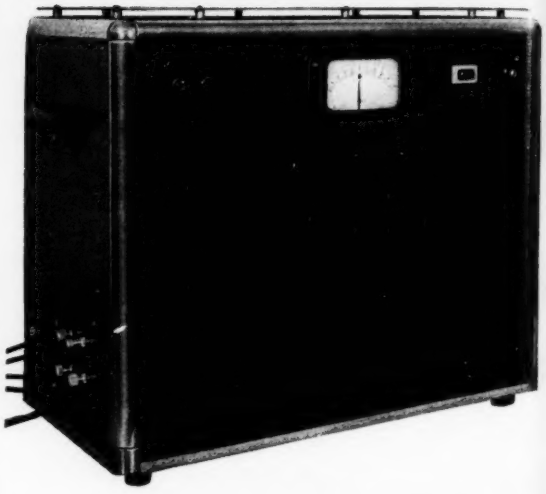

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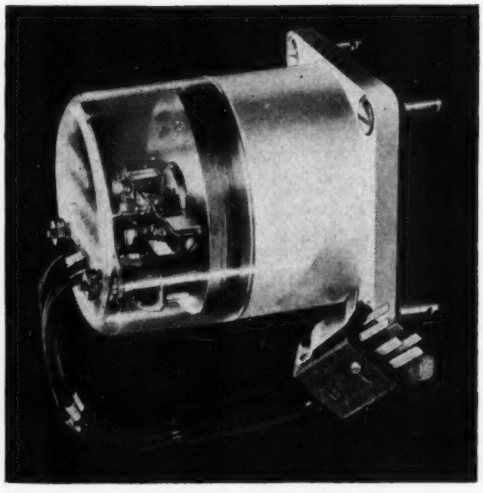

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PANEL MOUNTING INSTRUMENTS

2" · 2½" · 3½" · 5"

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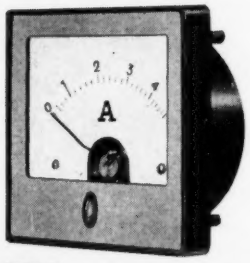

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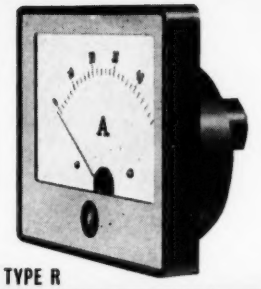

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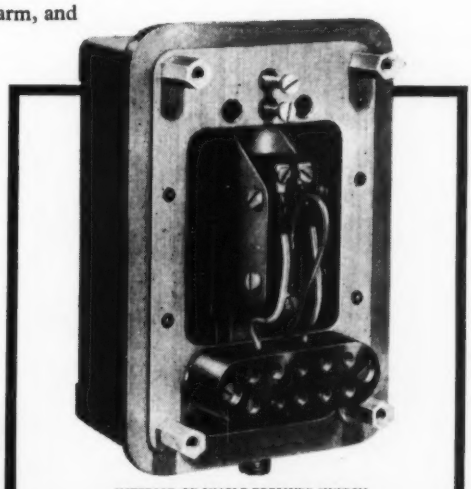

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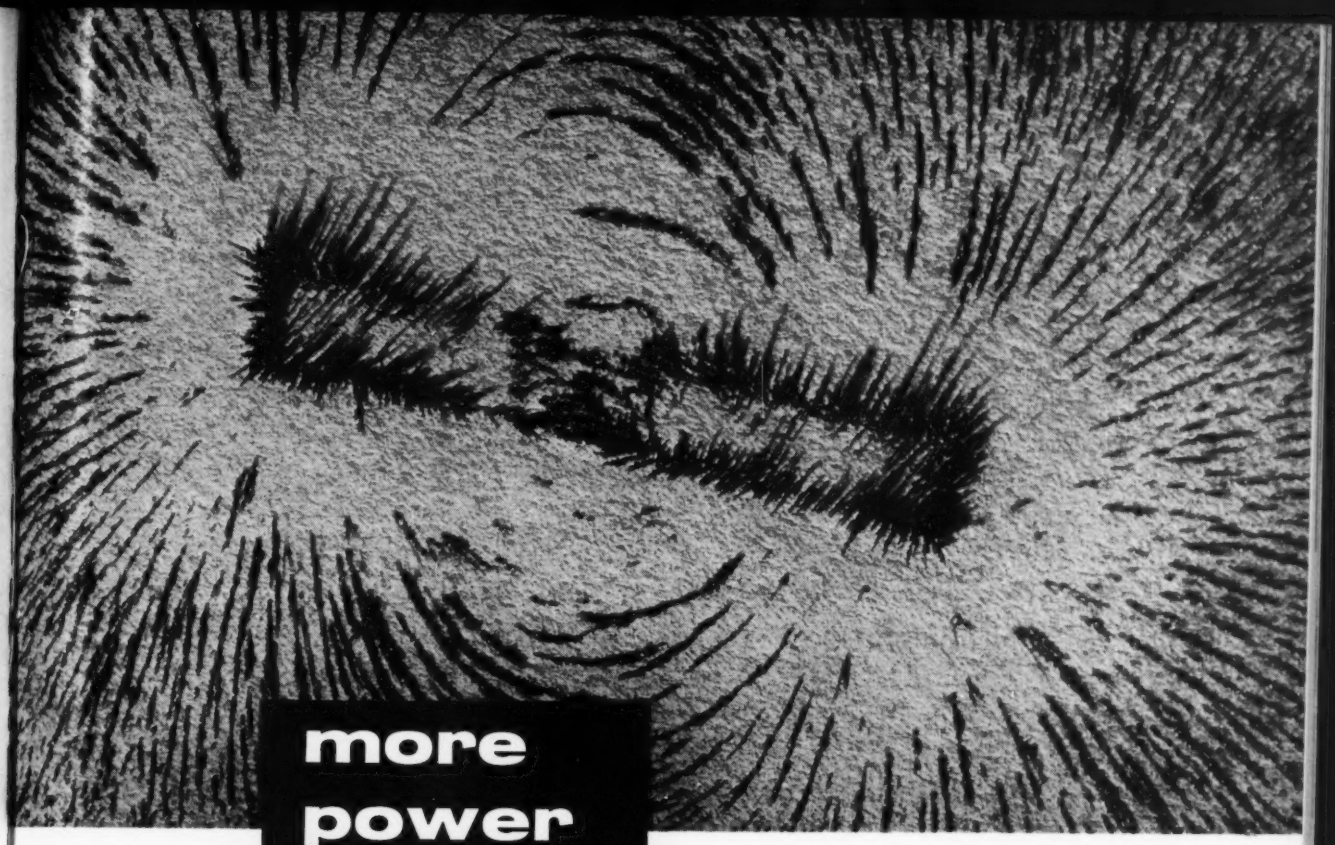

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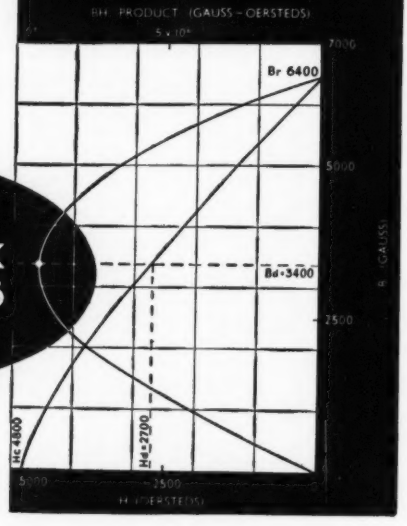

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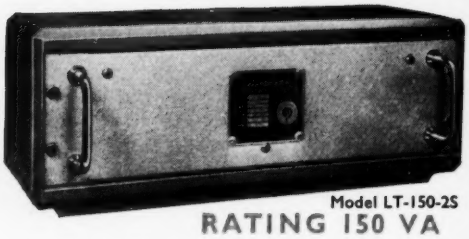

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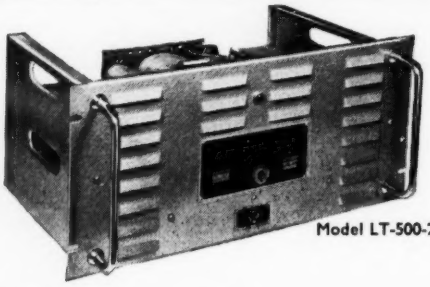

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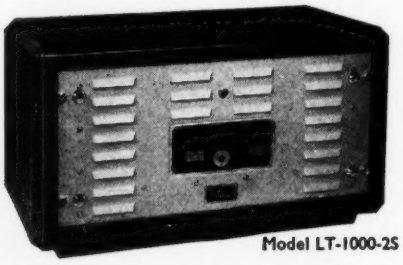

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VOL. 15. No. 7

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INSTRUMENT PRACTICE

COMMENTARY

Teaching Machines

Amongst the many factors involved in an automatic system, not the least important has been the replacement, wholly or partially, of the human link. Whilst the main effort has been directed towards industrial control, other fields of activity have received attention. The teaching profession is one of these, and several developments have been carried out under the general heading of Teaching Machines. Now, it is important to be clear on the real aims here. It has always been an axiom that a human instructor is essential in teaching but the manner in which he is employed varies to some extent with the size of his audience. On the one hand, we have a teacher or lecturer addressing a relatively large class, and, on the other, the tutor engaged with one or two students.

This is not the place to discuss, at length, the theory and practice of teaching, but without fear of contradiction one could state that a thorough understanding of the subject to be taught is required and lectures or lessons must be prepared and delivered in a very clear and logical manner. One of the most important functions involved in normal teaching is the exchange between teacher and students. In other words, the teacher can question the students to check their understanding and the students can clarify any points on which they are not clear with the teacher.

This interchange is, unhappily, severely modified with the trend to large classes in our schools, colleges and universities and the advantage of the tutorial system become even more apparent. At the beginning of the Commentary it was stated that one must be clear on the real aims, when introducing an automatic system into the teaching profession. What is intended? Is it an aid to the teacher, a partial replacement of the teacher or an entire replacement? The time is very apposite to consider the problem since there is a present shortage of teachers at all levels and an adequate supply is not likely to be achieved for some years to come. The subject of teaching machines has been under investigation by a team of three people, J. Annett, H. Kay and M. Sine, the work being financed by the D.S.I.R. Some of the results of their work has been reported in *Discovery* for May, 1961, page 191.

The law of effect is of considerable importance with relation to the general subject of teaching machines and this law states that learning occurs if a response to a specific situation is followed by some rewarding effect—rewarding, that is, to the learner. Under such circumstances, the response is said to be reinforced and reward can be known as reinforcement.

S. L. Pressey in 1926 devised a simple machine which tested a student's achievement. The student was presented with a set of questions each of which was accompanied by several answers, only one of which could be right. Each question on the machine was represented by a set of holes corresponding to the number of answers presented. The student was required to push a stylus into the hole corresponding to his own choice of answers. The stylus was allowed to pass through, only in the hole associated with the right one so that the student knew immediately if his choice was correct or not, the reward being the knowledge of choosing correctly.

Since the war, several American investigators, notably Professor Skinner, and Dr. Lumsdaine and Dr. Glaser, have carried out considerable research work and several devices have appeared. One of these is the programmed text book which consists of a programme of small logical steps arranged in book form. Each step is accompanied by a question to be answered by the student. The correct answer is on the back of the page and hence may easily be checked. As a contrast we have the Autotutor of U.S. Industries Inc. which is an example of the multiple choice idea. The student is presented with a variety of answers to each question, a push-button on the instrument corresponding to each answer. A correct choice results in the machine proceeding to the next part of the lesson. An incorrect choice results in the machine presenting an explanation or sequence of correctional material, and then reverting to the original question. The article also describes the British development of SAKI, primarily a device to train punched card keyboard operators. One point brought out in using such machines is that information is only passed on when the student is attending, an important distinction between human and machine teachers. It can be seen that we are some way on the road to tutorial instruction with such machines, particularly if further information could be supplied according to the needs, shall we say, of a backward student.

There are several factors which the authors discuss relative to the subject, but they consider that, in general, teaching machines could prove useful where (1) There is a shortage of human teachers; (2) Where individual or small groups of students are isolated from teachers; (3) Where the subject matter can be closely specified and placed in an appropriate form; (4) In subjects whose routine practice would benefit from accurate monitoring; (5) Where the student requires more attention and patience than a human teacher can be reasonably expected to give.

One must, of course, consider the cost aspect, but it is suggested that some of the machines, at least, will cost no more than that involved in training a teacher.

The subject is fascinating. We have seen many examples of automatic communication in other spheres replacing human links and here is yet another possibility of some significance.

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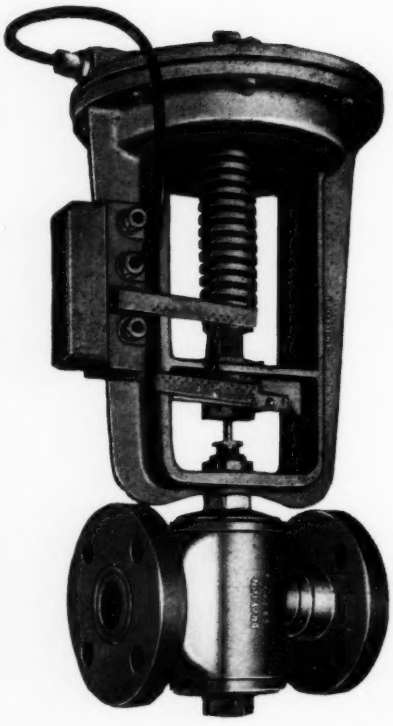

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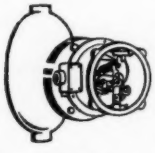

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The Presidential Address to the Society of Instrument Technology, 23rd May, 1961

Our Technology and Our Society

By G. C. ELTENTON, B.A., F.Inst.P.

Features of our Technology

SINCE I am going to attempt to review the position and prospects of our Technology and our Society it may be helpful to establish some sort of perspective before proceeding to controversy. According to Board of Trade figures, the value of deliveries of instruments of all types to all users, which is one but not the only way of measuring production, is approximately £100 million, exclusive of deliveries to the armed services. About 20% of these deliveries go to export and this represents very nearly 1% of the total U.K. exports.

Approximately 100,000 people of varying skills are employed in the making of instruments and control mechanisms, the labour content of which has been estimated at 75%. The rate of growth of the "Industrial Instrument" division of the industry has averaged 13% per annum (a figure which is about three times the corresponding figure for all manufacturing industries taken together) and this division, which is most closely allied to our Technology, now accounts for roughly one half of all instrument production.

I think that these figures, taken alone, reveal a minor industry, growing at a satisfactory rate, and making a small but not insignificant contribution to our exports. Such a picture would be misleading.

In the first place, the figures tell us nothing about the number of people employed in designing, installing and maintaining measurement and control systems. In most process industries the capital cost for effective measurement and control lies between 5% and 12% of the total capital investment in plants and a similar proportion of the total engineering force will be assigned to instrument maintenance and systems improvement.

Secondly, the figures conceal one of the most striking features of our Technology—its vital importance to nearly every other major technology. One has only to imagine what would happen in the majority of industries today if all measurement and control were suddenly eliminated to realise that such a contingency would be a national catastrophe. Just as a small amount of lubricating oil is vital to every bearing, so this apparently minor Technology of ours is becoming every day more vital to British Industry and to our survival as an industrial nation. The importance of our Technology, which is out of all proportion to its size as measured by the figures I have just given, presents major problems when considered in relation to the wide spread of its application in so many of our industries. If the application of our Technology were confined to one or at most two industries, the problems of organisation, education and training would be much simpler. Instrument Technology might then become a special branch of that industry. The very breadth of our Technology requires a radically different approach.

Before closing this survey of some features characterising our Technology, I should like to refer again to the rough statistics I gave earlier, in order to banish any feeling of complacency they may have evoked. Hardly a week goes by but some representative of our government exhorts the nation to export more and to increase its productivity. At times it is even necessary to throttle production because we cannot pay for the imports of the materials which full production would require. This is a problem which is relatively new to this country but very old to certain other countries such as Switzerland where exports are even more important to national survival than they are in this country. It is of course no accident that we associate watch-making with Switzerland. It is an industry similar in many ways to instrument manufacture where little raw material and much ingenuity and skill are required. Through the courtesy of the Swiss Embassy I was able to obtain a few figures which are not without some relevance. The total value of watches made in Switzerland is approximately the same as the gross value of instrument deliveries in this country—£100 million. But 97% are exported and this represents 15·5% of Switzerland's total exports. In 1952 the export of watches accounted for an even higher

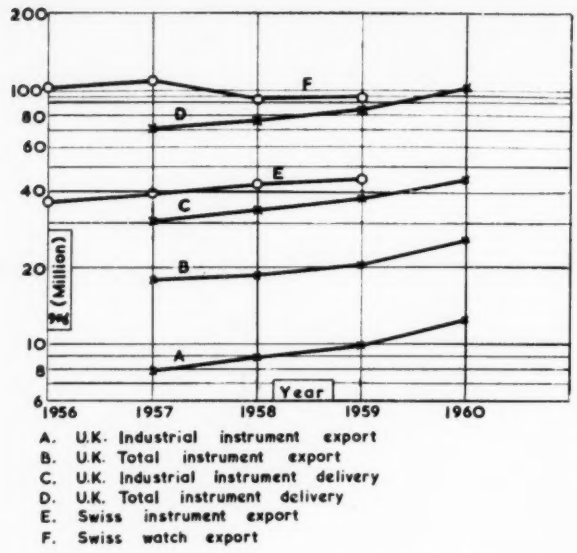

Fig. 1. *Comparison of instrument activity in U.K. and Switzerland*

percentage of the total—nearly 23% (Fig. 1). Between 1952 and 1960, therefore, there has been a decline in the relative importance of this export. During the same time, however, there has been an increase in the relative importance of exports of "Instruments and Apparatus"—from about 6·2 to 7·3%—and the value of these exports is approximately double the value of the U.K. instrument export. Thus it would appear that a country with one tenth the population of the British Isles is able to export twice the value of instruments that we manage to export from this country (Fig. 1).

It may well be that the figures supplied by our Board of Trade and those supplied by the Swiss Embassy[1] are not as comparable as I have chosen to make them. Definitions of the word "Instrument" are notoriously misleading. Thus a reputable newspaper which annually publishes a comprehensive table of wage indices[2] in different trades, compiled by reputable economists, dismisses instruments under the heading "Precision Instruments, Jewellery, etc." containing only the following sub-divisions: Orthopædic and Surgical Appliances; Surgical Instruments; Ophthalmic and Optical Appliances; Jewellery, Plate and Precious Metals; Pianoforte Manufacture. There is a nice Victorian ring about the last item and one wonders when the saxophone (a Swiss invention, incidentally) will qualify for inclusion. Instruments which can guide a space probe around the moon and transmit photographs of the hitherto unseen side have evidently a long time to wait before they qualify for recognition along with the upright and the baby grand.

It is perhaps only a coincidence that on the same page of the *Guardian* as the table referred to above there appeared also a report of the Graham Clark Lecture delivered by the Duke of Edinburgh to the Institutions of Civil, Mechanical and Electrical Engineers. In this the Duke pointed out that the Commonwealth, with 24% of the world's population, produced only 12% of the world's energy.

It is surely clear that engineers in this country face challenges such as we never faced before. Gone are the days when we could assure ourselves of our technological supremacy. We must mobilise our resources, both human and material, to meet the challenge presented by the new technologies among which automation is perhaps one of the most important, and the most neglected, particularly in the fields of education and professional recognition.

I have endeavoured to give some measure of this neglect by quoting figures of production and comparing these with related production and export in a much smaller and economically more vulnerable country such as Switzerland. But there are, of course, other indices of complacency and backwardness. One does not have to visit many processing plants to gain a strong impression that, while many of the instruments are made in this country, a high proportion of those in use, especially the more complex ones, have been designed in America. Sometimes, as in the case of gas liquid chromatography, the ideas and original scientific discovery are British. The "development gap" has claimed another victim, and it is little comfort to the instrument user that Martin and Synge were awarded the Nobel Prize. Visitors to the I.S.A. exhibition in the U.S.A., to the Interkama exhibition in Germany, and to the I.F.A.C. conference in Moscow, have almost unanimously reported that in these countries automation is taken more seriously and is progressing faster than in this country. Yet competition will drive our industries to more automation sooner rather than later. Are we, in our Technology, in our education and in our Society, preparing to meet this challenge?

Education

If we agree that there is a problem to be faced then I think that we, as a Society, must look first to the education and training of the technologists who will be needed to solve it. An instrument may be manufactured in a week, a factory may be erected in a year, but the training of a technologist takes at least twelve years from the time the boy leaves his elementary school. This is the distance velocity lag in the pipeline. Clearly a very large measure of anticipatory control is required. If today we need control technologists in dozens we shall probably need them in their hundreds in a few years as industry looks more and more to automation to remain competitive.

There is of course no universally agreed method of training control technologists. It has been my privilege while acting as your President to discuss this matter with many eminent people both within and outside our Technology. I think it can be said that a rather large majority of those working in our field are convinced that control technology is now so advanced in its targets and so wide in its scope that it is, or will soon be, recognised as a primary technology in the sense that a former President of this Society, Sir Harold Hartley, used that term[3]. But an equally large majority of those who are not familiar with the targets and scope of our Technology consider that we could solve our problem by relatively minor adjustments of

or additions to the curricula of other scientists or technologists—in particular the physicists, *or* the electrical *or* the mechanical engineers.

It is, however, meaningless to talk about education without defining the type of talent we want. The control engineer will have to master not only the basic principles and the more important techniques of mathematics, physics and electrical and mechanical engineering, but also he will have to be thoroughly grounded in the dynamic behaviour of systems in general and of a selected few, such as chemical engineering systems, in particular. In speaking of the control engineer or technologist as distinct from the technician I am assuming that the Society is in general agreement with the definitions of engineers and technicians adopted by EUSEC. These are reproduced in an Appendix together with a definition of a technician which was adopted at the Society's two-day conference on "The Education of Instrument Technicians" in September, 1959, and which, I think, supplements rather than replaces the EUSEC definition. There is, of course, a tendency in all such definitions to aim at an ideal. The standard implied is a high one, not always attained by all who qualify by examination and/or experience. A useful working life of some 40 or more years lies ahead of each who qualifies and it would be absurd to lay absolute and permanent stress on a man's showing in his four years of higher education. There is, however, a distinct danger that this folly may invade the technological and engineering field unless we keep clearly in mind the similarities and the differences between the academic and technological approaches.

If I had to choose one quality which would best serve to characterise the ideal in both science and technology it would undoubtedly be curiosity. If America is really bent on producing the "Organisation Man" she is bent on her own destruction. Yet it was America which produced the eminent engineer Charles Steinmetz who said "no man really becomes a fool until he stops asking questions" and it is Americans who, more recently, are revolutionising the teaching of physics, throwing out the deadwood and introducing the excitement and stimulation of that science[4]. I hope that this new and most promising experiment will be followed and, if successful, the lessons learned will be applied in the teaching of engineering and technology. For it is in these branches of learning that the danger of damaging the slender nerve of curiosity is most apparent. The danger of producing human "Encyclopaedia Erraticas" is all too real.

This digression into the tasks facing the educator may seem a far cry from my subject of education in our Technology. But it leads perhaps to a certain clarification of the Society's aims in this field. Granted that our Technology is a comparatively new one, it behoves us to avoid encumbering it at the outset with too much of the empiricism which grows like ivy round any tree of learning unless the pruning knife is used ruthlessly. This applies particularly to University undergraduate courses and at the risk of appearing dogmatic I would suggest that the Society should approach the problem of University courses in measurement and control technology with considerable caution. It might well be that if existing courses can be pruned of their deadwood, the fundamentals of dynamic behaviour and control can be introduced with profit into several of them. It has taken the Chemical faculties a long time to introduce kinetics of chemical reactions into their syllabuses. Equilibrium conditions are so much more tractable! Let us hope that the Physics, the Chemical and other Engineering faculties will soon pay more attention to the non-equilibrium behaviour of their systems. Dare one suggest that Glaswegians might have been saved much disappointment and frustration in their railway modernisation if such behaviour had been given more priority?

There is, I am sure, much room for discussion of what we should like the Universities to provide. Relegation of measurement and control technology to post-graduate courses exclusively will not meet the need. It is precisely the new technologies which are at a disadvantage in attracting students to spend the extra year or two which would be required. The seed of interest in the subject has to be sown much earlier and I should like to see an extension of the method used at Imperial College where a central group of control engineers are able to penetrate various disciplines, thus introducing the basic concepts more widely. Interim measures, however, may run the risk that they postpone the introduction of more profound courses which are required to produce the type of man who can conceive the control schemes in a total form.

Colleges of Advanced Technology

While I have expressed some doubt as to the wisdom of teaching Measurement and Control Technology as a subject on its own in Universities for the present, I have no such doubts as to the necessity of teaching it as a primary technology in CATS. If we are to hold our own it is essential that new technologies should find quick development in such establishments and encouragement should be given to post-Diploma research. It would seem that CATS should be encouraged to develop these new technologies by generous government grants, and to develop them fast. If, as I endeavoured to show in the opening paragraphs, automation is gathering momentum both here and abroad, we cannot afford any more time lags. The CATS, or a selected few of them, should be thinking ahead. In this respect we can congratulate Northampton College of Advanced Technology and those firms who had the foresight to sponsor students at a time when the course was little more than a scheme on paper. The role of the Society is of course to lend friendly help, but to avoid interference with the educators who design the course, to recognise the Diploma as a desirable qualification, to encourage our Members and Patrons to support the course, to encourage students by the award of prizes, and to press for similar courses in areas outside London.

What do we mean by the words "recognise the Diploma as a desirable qualification"? If I were a student entering a course in Measurement and Control at a CAT I should be confused and irritated by such obscure language. I should want to know whether recognition by the S.I.T. meant as much as recognition by a qualifying body such as an established Institute or Institution. The plain answer is of course that it

does not. Quite apart from the obvious prestige of the long-established Institutions and their understandable reluctance to help in the establishment of new ones—facts which did not prevent the Institution of Chemical Engineers from becoming ultimately a great asset to the nation—the Board of Trade appears to me to be applying a rather dangerous test to those bodies such as ours which apply for the right to become qualifying Institutions in a new technology. Thus they will only grant the right to us if we have already achieved professional status in our field and are already recognised as a qualifying body setting standards for entry to our profession, usually by examination and experience combined.

I think it would be fair to say that our Society considers it to be the duty of the government to assist new technologies which are playing the vital role which, I have endeavoured to demonstrate, ours is playing. We should not be asked to solve the problem of the chicken and the egg. We see a need for recruiting the best into our profession, but education authorities, students and employers need to know where we stand on the subject of professional recognition before establishing and supporting courses if progress is to keep pace with demand.

Colleges of Technology

These are, and will for some time remain, the main avenue of recruitment into the engineering profession. The major Institutions owe more than half their present membership to this avenue and although they are now in a position where they can and have raised the requirements for corporate membership so as to make it increasingly difficult for this path to be used, I hope that it will never be entirely closed. In a new technology such as ours we must make as much use of the Technical Colleges as we can. I propose therefore to discuss the problems involved in greater detail.

Until the publication recently of the Government White Paper on "Better Opportunities in Technical Education"[5] the National Certificate courses were, in practice if not in theory, regarded as fulfilling the dual function of providing more or less fundamental, as distinct from craft, training for technicians and as stepping stones to a professional qualification. The failure rate was very high. The White Paper proposes the creation of technician courses, less theoretical in content than the Certificate courses which are to be retained as a means of training very high grade technicians and as stepping stones towards a professional qualification pending the introduction of sufficient Dip. Tech. and University courses to satisfy the demand for qualified engineers. With the introduction of technicians' courses the qualifications for entry into the Certificate courses will be raised, thereby reducing, it is hoped, the failure rate during the course itself.

It is self-evident, I think, that the more talented boys will want to pursue the Certificate courses. Moreover, many of them will, either initially or later, set their sights at professional status. They will therefore choose those Certificate courses which lead to post-HNC courses recognised by the professional Institutions. It follows therefore that if none of the present Certificate and post-HNC courses satisfy the training requirements for producing high grade technicians or technologists in Measurement and Control Technology, three lines of action are open to the Society.

1. It can endeavour to set up HNC and post-HNC courses in Measurement and Control
2. It can try to establish post-HNC courses which students with Higher National Certificates in either Applied Physics or Electrical or Mechanical Engineering can take
3. It can attempt to influence the major Institutions, including the Institute of Physics, to inject sufficient Measurement and Control Technology into their existing syllabuses to satisfy the requirements of industry.

I need hardly say that the last of these alternatives is regarded in our Education Committee as highly theoretical, and fraught with difficulty and frustration.

A sub-committee which examined the second and seemingly simplest alternative drew up a scheme which was submitted to approximately 150 industrial and educational authorities.

The scheme consisted of suggested syllabuses in the subjects shown in Table 1. You will note that in the first year after obtaining an HNC it was found necessary to segregate mechanical engineers from the electrical engineers and from the physicists. This is because the mechanical engineer at this stage was considered to be deficient in mathematics and physics whereas the physicist and electrical engineer are lacking in the more mechanical and practical sciences. It was necessary also to compromise in the interest of economy in teaching staff and viability of classes which might be expected to be small initially.

In the second year you will see that all students take the same subjects but it is possible for the student or the College to choose alternatives in Subject 10 according to whether the local industries served are predominantly users or manufacturers of instruments.

TABLE 1
Post-HNC Course for the Professional Examination in Measurement and Control

	Subject	ME	EE	P
	FIRST YEAR			
1	Measurement and Control	X	X	X
2	Instrument Design	—	X	X
3	Practical	—	X	X
4A	Materials (½ year)	—	m	X
4B	Technical Drawing (½ year)	—	m	X
5	Mathematics	X	—	—
6	Electrical Technology	X	—	—
7	Engineering Physics	X	n	—
	SECOND YEAR			
8	Advanced Measurement and Control	X	X	X
9	Electronics	X	X	X
10A	Instrumentation of Processes	p	p	p
10B	Design and Production in Instrument Manufacture	q	q	q

m, n—Alternatives depending on students' knowledge of Physics.

p, q—Alternatives depending on dominant interest of local industry.

Among many lessons learned from this exercise I would mention two. In the first place it was very difficult to construct a conversion course which would fit into a two-year day-release scheme. In other words, there is too much to learn, and although the student would be much more use in Measurement and Control Technology if he had taken our course, he would be an even better man if he had started on a well-designed course after getting his ONC rather than after his HNC. The second lesson learned from replies to our questionnaire was the one we had anticipated. It would be necessary to offer the successful student some form of professional recognition.

Structural Changes

The structural changes which we must make if we are to help this new and vital technology are very similar to those which other qualifying bodies have had to make in the past when confronted with the same problem. No one would, I think, deny that the major and many other qualifying Institutes and Institutions have made an enormous contribution to the advancement of their various technologies as a result of their influence on training and education. Their structures have been studied in some detail by committees of the Society and this is neither the place nor time to elaborate on this aspect of their recommendations.

There is, however, one departure from the general pattern which it is important to explain. It is particularly the modern technologies which create an increasing demand for what we call the technician. The technologist or engineer is becoming more and more desk-bound as a recent survey among chemical engineers demonstrated clearly and somewhat alarmingly. Increasingly he needs the assistance of competent technicians to maintain his own efficiency. With experience many of these technicians become at least semi- if not completely professional in their outlook. The technologists, particularly the young ones, have much to gain and nothing to lose by close association with technicians of the calibre we require. Our Society has already proved this, particularly in our Local Sections. We are recommending, therefore, that whatever final structure we adopt (and are allowed to adopt) we must retain the Associate as an honoured member. We should, I think, look forward to the time when the words Associate and Technician represent a position in the Society of considerable weight. To achieve this, however, we may have to convince others that structures found adequate for the older technologies are not necessarily ideal for today's newcomers. I hope we shall succeed.

In the meantime we have set up a sub-committee to investigate the training of technicians and we are glad to find that both the City and Guilds of London Institute and the Ministry of Education are anxious to help. So I am sure is the Education Panel of the B.C.A.C., although this new body has hardly had time to get to grips with the problem.

If we are bent on raising the status of the technician, it is necessary to consider the appropriate height of the hurdles over which one might reasonably expect him to pass. The components of a hurdle may consist of age, experience and academic qualifications. These components, taken in varying severities, define the overall severity of the hurdle.

TABLE 2

A proposed set of requirements for Associateship and the percentage of recent candidates who would pass or fail

Proposed requirements			
Academic	**Age**	**Experience**	**% Passing**
HNC	—	—	36
ONC or C & G	24+	5+	26
None	28+	8+	18
			80

Cause of failure	**% Failing**
ONC but age less than 24	6
No qualification, age less than 28	14
Insufficient experience	0
	20

I know that some Chairmen of Local Sections have been alarmed at the thought of introducing any hurdles for our future Associates. They fear that many potential new members will be excluded. I have therefore analysed the cases of one hundred recent applicants to see how they would have fared if what is considered a reasonable hurdle were established. The results of this analysis are given in Table 2 where it will be seen that the proposed requirements would be met by 80% of those who applied and that, of the 20% who would have failed initially, all could have passed after the passage of time. During this interval all the 20% could be accommodated in a grade which may be called "Subscribers", assuming that none of them was eligible to be graded as Students. Thus none would be excluded from the Society but the Associate grade would be open to the more qualified. In time we would hope that this grade would become recognised among employers of technicians in the same way as Associate Membership will be recognised for technologists.

The Future

The rate of growth of the Society is a healthy one. This is to be expected in a rapidly expanding technology. But many of us feel that it is the duty of the Society to look ahead and that means setting up the kind of organisation which can encourage entry into the profession. The major Engineering Institutions would prefer us to remain a "Learned Society". We can understand but not agree with their point of view. We must demonstrate to them and other bodies such as the Board of Trade that the present educational routes into our profession are crude and haphazard. They are likely to produce neither the quality nor the quantity required. We can also, I think, affirm and demonstrate that our technology has already a vigorous and dedicated professional nucleus. In Table 3 I have tried to summarise an analysis of one hundred recent applicants for membership. 41% had first degrees or better which compares very favourably, I believe, with the corresponding figure pertaining to at least one of

TABLE 3

Data on recent applicants accepted for full Membership

Main subject studied	%
Electrical Engineering	39
Mechanical Engineering	22
Physics	17
Mathematics	7
Chemistry	4
Chemical Engineering	3
Fuel Technology	2
Metallurgy/Glass/Transport	3
General	3
Average age of applicants	36·3 y
% with 1st Degree or higher	41
Membership in other Technical organisations	54%
Membership in more than one other Technical organisation	13%

the major Engineering Institutions. 54% were members of other professional bodies. The wide range of subjects via which Members have entered our Technology indicates, to anyone versed in the syllabuses of these subjects, how ill-prepared in general these men were at the outset of a career in Measurement and Control Technology to make the kind of impact which we require if we are to compete successfully with those foreign countries I have already mentioned where a career in our Technology is made more attractive.

The future, therefore, is in the balance. It has been impossible to avoid the appearance of criticism, sometimes of organisations which have no means of reply directly to our membership. Perhaps, therefore, I may be permitted to quote once more from a paragraph in the Graham Clark Lecture[5]: "a little mild and well intentioned criticism, even if its accuracy is disputed, should be treated as a signpost rather than as a slander". I am sure that all concerned are anxious that this country should achieve a position of technological efficiency second to none.

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2. *Guardian*, 14th April, 1961.
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APPENDIX

Definitions of "Professional Engineer" and "Engineering Technician" adopted by EUSEC* and of "Instrument Technician" adopted at the S.I.T. Conference on Education in London, September, 1959.

(*) Engineering Societies of Western Europe and the U.S.A.

Professional Engineer

A professional engineer is competent by virtue of his fundamental education and training to apply the scientific method and outlook to the analysis and solution of engineering problems. He is able to assume personal responsibility for the development and application of engineering science and knowledge, notably in research, designing, construction, manufacturing, superintending, managing and in the education of the engineer. His work is predominantly intellectual and varied, and not of a routine mental or physical character. It requires the exercise of original thought and judgment and the ability to supervise the technical and administrative work of others.

His education will have been such as to make him capable of closely and continuously following progress in his branch of engineering science by consulting newly published work on a world-wide basis, assimilating such information and applying it independently. He is thus placed in a position to make contributions to the development of engineering science or its applications.

His education and training will have been such that he will have acquired a broad and general appreciation of the engineering sciences as well as a thorough insight into the special features of his own branch. In due time he will be able to give authoritative technical advice, and to assume responsibility for the direction of important tasks in his branch.

Engineering Technician

An engineering technician is one who can apply in a responsible manner proven techniques which are commonly understood by those who are expert in a branch of engineering, or those techniques specially prescribed by professional engineers.

Under general professional engineering direction, or following established engineering techniques, he is capable of carrying out duties which may be found among the list of examples set out below.

In carrying out many of these duties, competent supervision of the work of skilled craftsmen will be necessary. The techniques employed demand acquired experience and knowledge of a particular branch of engineering, combined with the ability to work out the details of a task in the light of well-established practice.

An engineering technician requires an education and training sufficient to enable him to understand the reasons for and purposes of the operations for which he is responsible.

The following duties are typical of those carried out by engineering technicians:

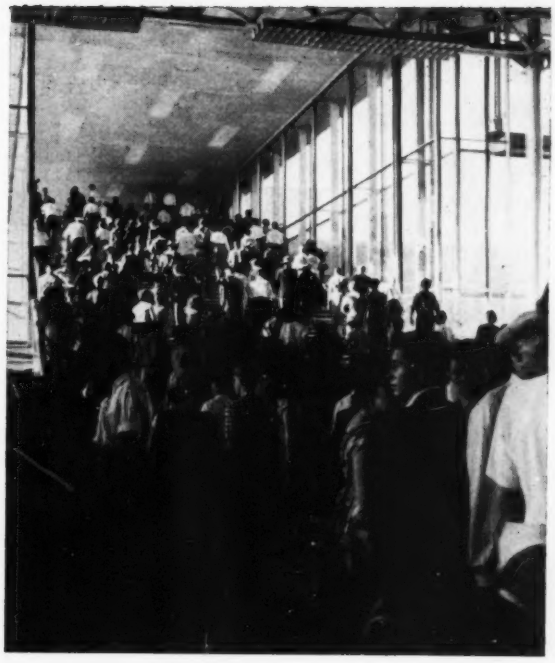
Working on design and development of engineering plant and structures; erecting and commissioning of engineering equipment and structures; engineering drawing; estimating, inspecting and testing engineering construction and equipment; use of surveying instruments; operating, maintaining and repairing engineering machinery, plant and engineering services and locating defects therein; activities connected with research and development, testing of materials and components and sales engineering, servicing equipment, and advising consumers.

Resolution passed at S.I.T. Conference

That the needs of industry in relation to Technicians be defined as follows:—

Between the craftsmen who can undertake instrument maintenance and the graduate engineers who develop new plant and are usually in charge of the starting up of new plant, industry needs technicians, who will be expected to be able to:

1. Learn, after a reasonably short period of instruction, sufficient about a plant and its instrumentation to supervise the installation, operation, maintenance and repair of its control system;
2. Be responsible for the correct operation of analysis instruments (which has been found to be beyond the capabilities of the trained craftsmen);
3. Advise on problems met in the installation, maintenance and repair of control systems;
4. Design and/or assist in the development and design of new instruments and control schemes, working either in the drawing office or the laboratory;
5. Evaluate control instruments and control schemes;
6. Assist in the detailed work involved in planning new control schemes and selecting instruments for them;
7. Examine problems submitted by users, and make recommendations for their solution.



BRITISH TRADE FAIR, MOSCOW, 19th MAY — 4th JUNE

As seen by one of the British Instrument Exhibitors

THE recent British Trade Fair in Moscow was by far the largest foreign Fair ever held in The Soviet Union and was one of the largest all-British Fairs ever held overseas. Last year SIMA put on a ten-day instrument exhibition in Moscow*, and it is interesting to compare last year's experience with this year's when SIMA showed at the British Trade Fair.

The Fair was held at the Sokolniki Park of Rest and Culture, the SIMA exhibit being housed in Hall C, a glass structure with some air conditioning. The first week of the exhibition was very cold with temperatures down to 47°F. In the second week, however, we had the other extreme with temperatures in the 80°s (the maximum I noted was 94°F) and humidity of 65%.

The Fair was open twelve hours a day, seven days a week, and for many of the smaller firms who brought over limited staff it meant being on duty the whole time. At least 75,000 people visited the Fair each day, and including the V.I.P.'s I would estimate the visitors at 100,000 a day. This pressure was kept up right to the very last minute. There was still a demand for further tickets, and we were approached by people in the street and even by taxi drivers asking if we could get them tickets.

The first 1½ hours of each day was set aside for experts, though, of course, these were also liable to appear later in the day. Thus, every visitor to the stand had to be treated seriously, although in a large number of cases souvenirs in the form of technical literature and brochures were all that they were after. Towards the end of the time our interpreters were becoming quite efficient at discriminating between genuine enquiries and these souvenir collectors.

A lot of the instrument firms at the Fair sold less than they thought they would. This was not because of lack of interest but because of the quota system limitation.

Last year Russia's quota was £450,000 and this has been increased by 50% this year. The U.S.S.R. certainly wants more British instruments than they are at present allowed, but there must be more two-way trade between the countries. There would have been much more business done without their quota limitation. Mashpriborintorg were swamped with requests and no doubt more orders will follow as a result of the Fair.

" Export Efforts Still Not Enough." This cutting from the *Financial Times* has been pasted by one wit on to the back of the door of the SIMA refreshment room. Those of us who were on the spot twelve hours a day throughout the Fair . . .

*Reported in *Instrument Practice*, August, 1960, pp. 862-865.

Analysis of Flow Test Data

By R. G. WEST*

THE preceding articles have attempted to explain the basic problems connected with pressure loss and to describe the practical difficulties of solving them.

In particular, it was stressed that the choice of the axial location of the pipe wall tappings, by which irrecoverable pressure loss is measured, relative to the primary element, needs careful consideration.

Pressure Tapping Positions

The positions most often used are one pipe diameter upstream and ten pipe diameters downstream, but there seems to be no technical justification for this choice. Indeed the vague statement is often made apropos of the downstream position that, at that point, recovery is complete without qualification as to the type of primary element or the value of area ratio m.

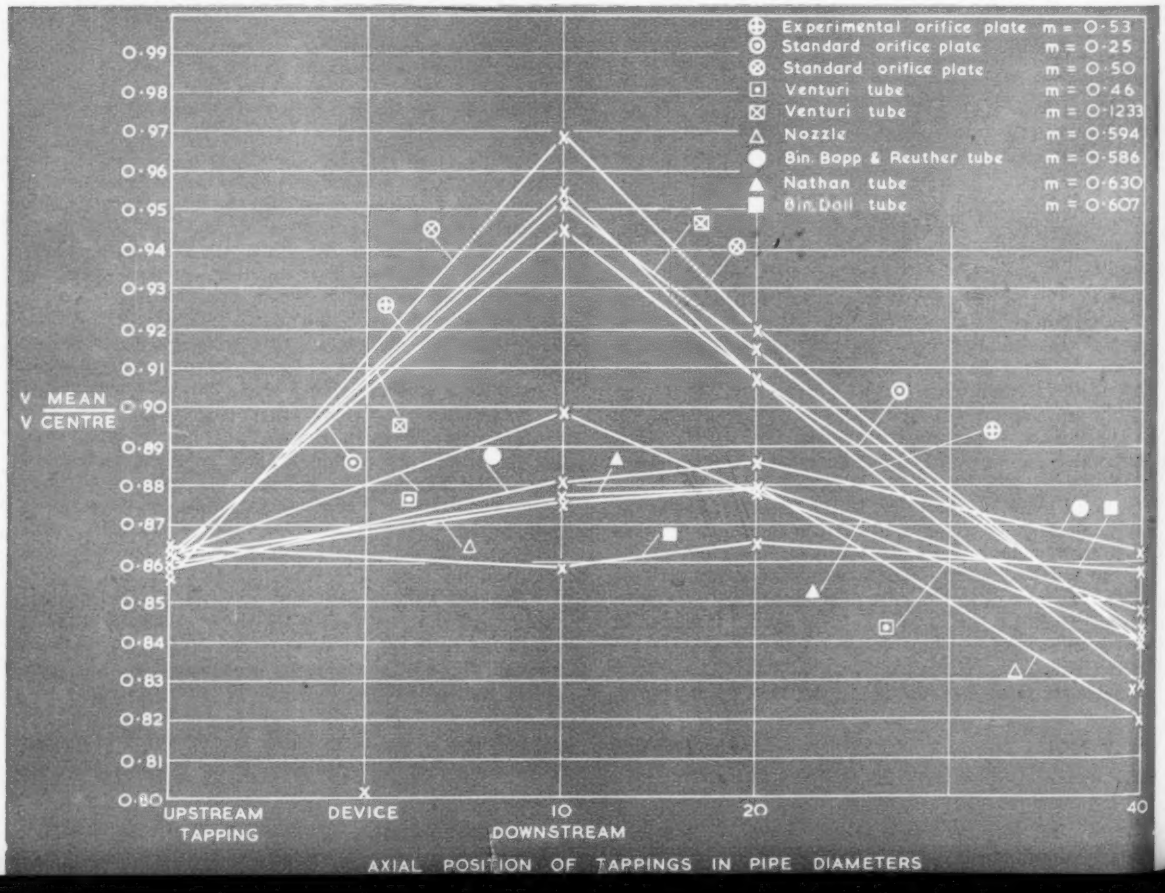
Yet, as with coefficient data, velocity distribution provides a method by which valid positions of these tappings can be chosen. The influence of a constriction in a pipe can only be said to have ceased when the profile of velocity distribution downstream has been restored to that which would exist for undisturbed flow.

In the following discussion, this position of restoration measured from the *downstream face* of an orifice plate, from the midpoint of a throat to the centre line of a given downstream tapping, will be called the plane of identity.

Pressure Recovery and Velocity Profile

As a subsidiary phase of the pressure loss investigation, some initial tests using a variety of devices were made in both the 6 in. and 8 in. test air lines, consisting entirely of pipes of uniform roughness ($\lambda = 0{\cdot}017$).

Fig. 1(*a*) *Summary of tests in a* 6 *in. air line* $\lambda = 0{\cdot}017$



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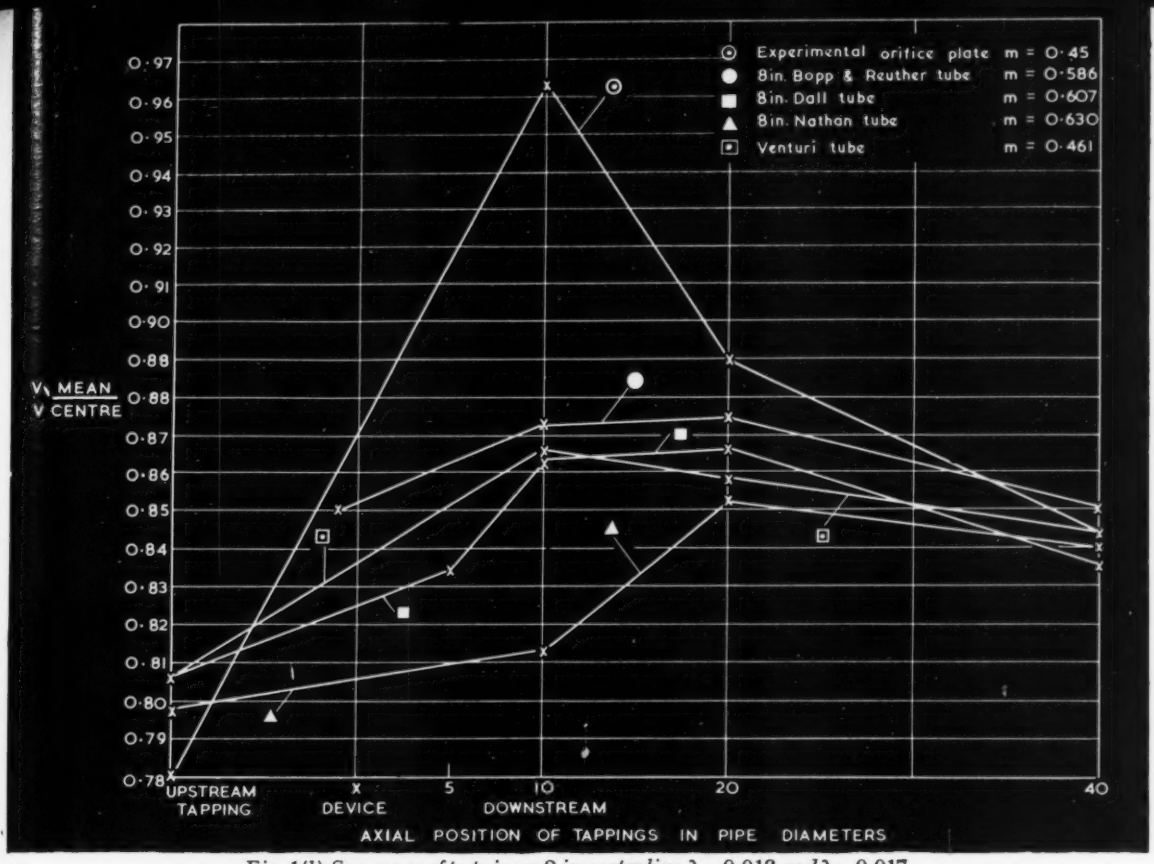


Fig. 1(b) Summary of tests in an 8 in. water line $\lambda = 0{\cdot}013$ *and* $\lambda = 0{\cdot}017$

The purpose of these tests was to provide some preliminary evidence that pressure recovery is or can be related to velocity profile form. (Fig. 1 (a))

The results of these tests show that classification is straightforward: the type of primary element obviously controls the plane of identity while area ratio is of secondary importance. Velocity distribution pattern is clearly related, as expected, to the geometry of the particular device. Thus, in order of pattern and using the orifice plate as one extreme, come the experimental orifice plate, Venturi tubes, nozzle, Dall tube, Nathan tube and finally Bopp and Reuther tube.

In general, those devices that preform the flow, such as the nozzle, have downstream velocity profiles which show that the change in distribution caused by the constriction is very gradual and temporary. An interesting exception is the low area ratio Venturi tube which, at a distance 10 diameters downstream, has caused a distribution almost identical to that after an orifice plate. In addition, it can be mentioned that the profiles after orifice plates ($m = 0{\cdot}25$, $m = 0{\cdot}50$) are almost indentical and independent of area ratio, whereas those for the Venturi tubes ($m = 0{\cdot}123$, $m = 0{\cdot}46$) are different at any given location and vary considerably with area ratio.

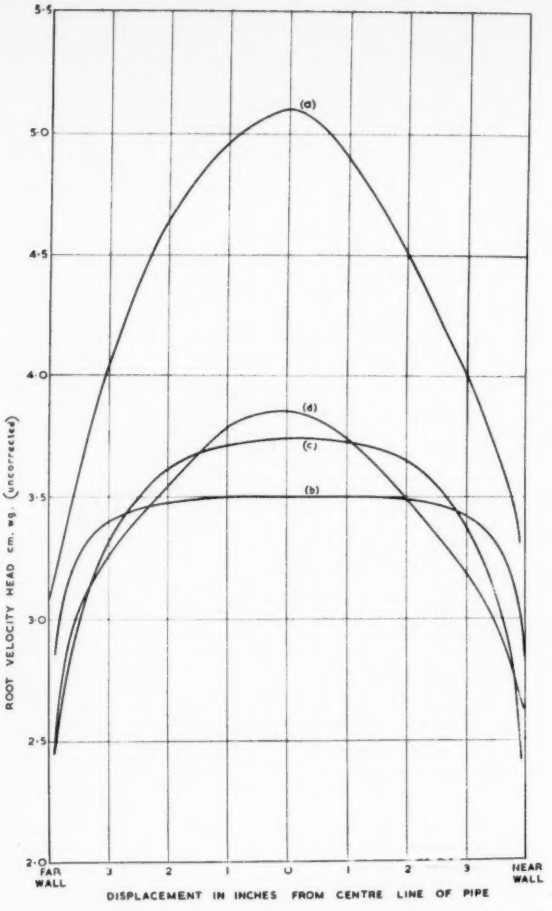
Thus, these tests suggest that the nozzle Venturi profile, described elsewhere in these articles as a compromise, does not produce a pressure/velocity distribution which is independent of area ratio. This underlines the importance of the axial position of the throat pressure hole in the matter of discharge coefficient characteristics. It also helps to show why the energy losses ought to be expressed in a manner independent of the differential head.

The last remarks apply to the standard thin plate orifice, for although the downstream distribution is almost independent of area ratio, there is a most drastic re-orientation of energy as is clear from a comparison of the profiles 20 diameters upstream and those 10 and 20 diameters downstream. These initial tests show that there is a correlation between axial position of traverse and V_m/V_c.

Fig. 1 (a) is important because it not only shows that correlation exists, but that the vertical order of the plotted lines and the position of maxima follow a logical pattern.

There is an apparent anomaly of V_m/V_c values for the orifice plate $m = 0{\cdot}25$ and Venturi $m = 0{\cdot}46$. This is due to the fact that air plant limitations caused these two devices to be tested at lower Reynolds numbers than the others for which curves are plotted. But this is of secondary interest, since it is the axial position of the various maxima which are of significance.

It is clear that devices which create high pressure differentials, such as low ratio orifices and Venturis, produce downstream of the device a mechanism of turbulent mixing, which causes, by comparison, a more rapid restoration of velocity profile. This is achieved at the expense of considerable irrecoverable energy losses.



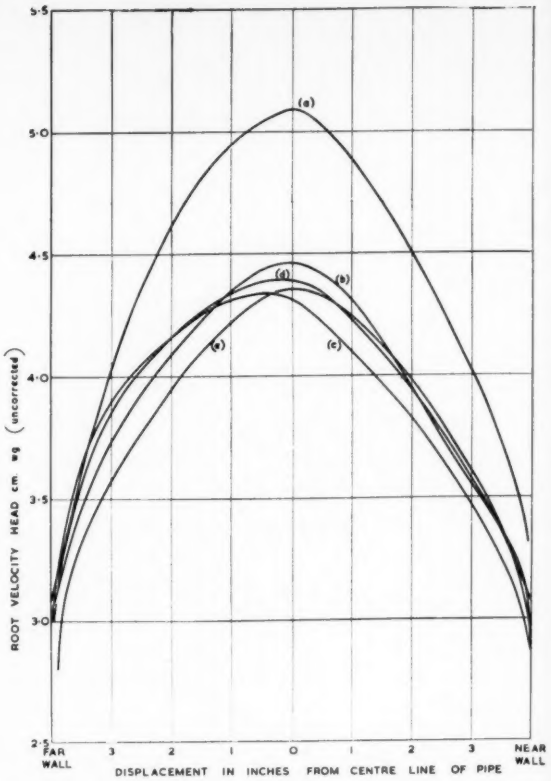
▲*Fig.* 2. *Velocity profiles for an experimental orifice plate in an* 8 *in. water line*
$m=0{\cdot}45$ $\lambda=0{\cdot}013$ $R_D>500{,}000$

(*a*) 20 *diameters upstream*
$\alpha=1{\cdot}05$ $V_{mean}/V_{centre}=0{\cdot}806$

(*b*) 10 *diameters downstream*
$\alpha=1{\cdot}009$ $V_{mean}/V_{centre}=0{\cdot}964$

(*c*) 20 *diameters downstream*
$\alpha=1{\cdot}036$ $V_{mean}/V_{centre}=0{\cdot}889$

(*d*) 40 *diameters downstream*
$\alpha=1{\cdot}028$ $V_{mean}/V_{centre}=0{\cdot}844$



▲*Fig.* 3. *Velocity profiles for a Dall tube in an* 8 *in. water line*
$m=0{\cdot}607$ $\lambda=0{\cdot}017$ $R_D>500{,}000$

(*a*) 20 *diameters upstream*
$\alpha=1{\cdot}05$ $V_{mean}/V_{centre}=0{\cdot}806$

(*b*) 5 *diameters downstream*
$\alpha=1{\cdot}028$ $V_{mean}/V_{centre}=0{\cdot}834$

(*c*) 10 *diameters downstream*
$\alpha=1{\cdot}029$ $V_{mean}/V_{centre}=0{\cdot}853$

(*d*) 20 *diameters downstream*
$\alpha=1{\cdot}028$ $V_{mean}/V_{centre}=0{\cdot}856$

(*e*) 40 *diameters downstream*
$\alpha=1{\cdot}032$ $V_{mean}/V_{centre}=0{\cdot}835$

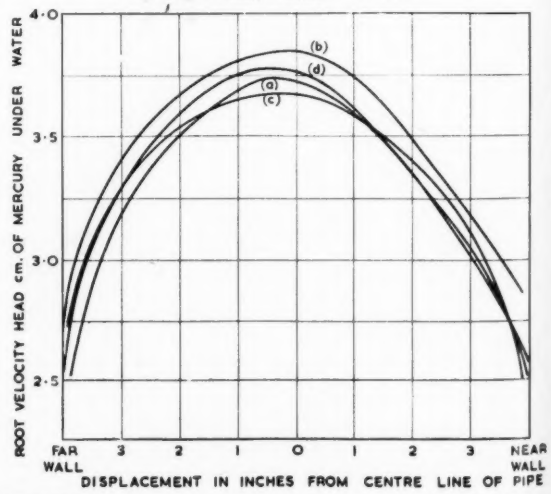
Fig. 4. *Velocity profiles for a Bopp & Reuther tube in an* 8 *in. water line*
$m=0{\cdot}586$ $\lambda=0{\cdot}017$ $R_D>500{,}000$

(*a*) 1 *diameter upstream*
$\alpha=1{\cdot}052$ $V_{mean}/V_{centre}=0{\cdot}850$

(*b*) 10 *diameters downstream*
$\alpha=1{\cdot}02$ $V_{mean}/V_{centre}=0{\cdot}872$

(*c*) 20 *diameters downstream*
$\alpha=1{\cdot}03$ $V_{mean}/V_{centre}=0{\cdot}874$

(*d*) 40 *diameters downstream*
$\alpha=1{\cdot}052$ $V_{mean}/V_{centre}=0{\cdot}850$



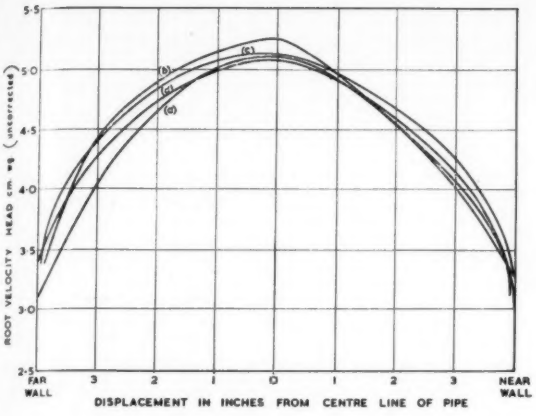


Fig. 5. *Velocity profiles for a Nathan tube in an 8 in. water line*
$m=0{\cdot}630$ $\lambda=0{\cdot}013$ $R_D>500{,}000$
(*a*) 20 *diameters upstream*
$\alpha=1{\cdot}05$ $V_{mean}/V_{centre}=0{\cdot}806$
(*b*) 10 *diameters downstream*
$\alpha=1{\cdot}044$ $V_{mean}/V_{centre}=0{\cdot}813$
(*c*) 20 *diameters downstream*
$\alpha=1{\cdot}031$ $V_{mean}/V_{centre}=0{\cdot}852$
(*d*) 40 *diameters downstream*
$\alpha=1{\cdot}034$ $V_{mean}/V_{centre}=0{\cdot}840$

In contrast, the new flow tubes cause a V_m/V_c gradient which takes longer to reach a maximum but which is able to resolve less abruptly.

The nozzle has a similar gradient with a maximum at the same point along the test line, but the gradient deteriorates badly at almost the same rate as that of an orifice plate, due to the absence of an outlet divergent cone to help reduce energy losses.

From the aspect of natural philosophy it is remarkable that the natural distribution of the pipe is reasserted irrespective of the type of obstruction and even at the expense of great energy losses, in more or less the same length of pipe.

Pressure Loss Tests

The main series of pressure loss tests on the experimental orifice plate, the Dall tube, Bopp and Reuther tube and Nathan tube, in the 8 in. test water line, can now be discussed and some results are shown in Figs. 1 (b), 2—5.

For purposes of comparison, similar water tests were also made on an 8 in. nozzle Venturi tube m = 0·46, Fig. 6.

There is agreement between these and the air tests and it is now clear that of all devices tested the Dall tube alone causes the least modification to velocity profile and thus to the ratio V_m/V_c or to α. No doubt the secondary throat in the Bopp and Reuther tube is responsible for the slightly greater changes in velocity distribution after this device.

In the Nathan tube, there is neither an inlet step nor a secondary throat and most important of all no nozzle form or similar means of preforming the flow. The inlet cone does not, in the absence of a parallel throat (as in the classical Venturi), enable a uniform velocity

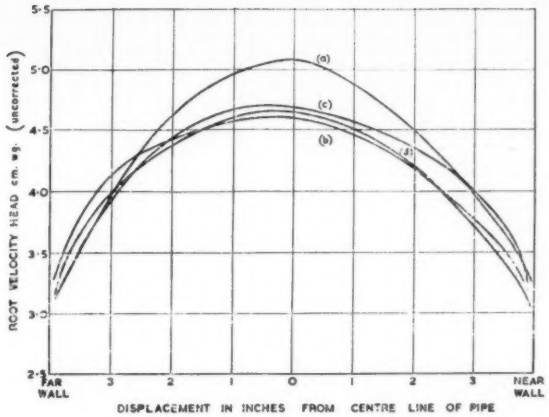
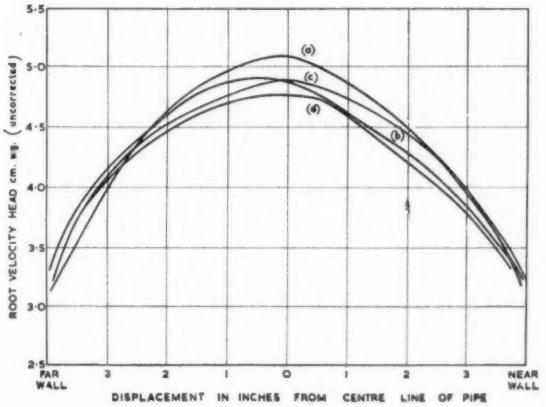


Fig. 6. *Velocity profiles for a nozzle Venturi tube in an 8 in. water line*
$m=0{\cdot}46$ $\lambda=0{\cdot}013$ $R_D>500{,}000$
(*a*) 20 *diameters upstream*
$\alpha=1{\cdot}05$ $V_{mean}/V_{centre}=0{\cdot}806$
(*b*) 10 *diameters downstream*
$\alpha=1{\cdot}03$ $V_{mean}/V_{centre}=0{\cdot}866$
(*c*) 20 *diameters downstream*
$\alpha=1{\cdot}034$ $V_{mean}/V_{centre}=0{\cdot}858$
(*d*) 40 *diameters downstream*
$\alpha=1{\cdot}038$ $V_{mean}/V_{centre}=0{\cdot}843$

distribution in the plane of the throat tapping to be achieved. As a result this tube produces a greater modification to the inlet velocity distribution than do the previous two.

Fig. 7. *Velocity profiles for an 8 in. water line with no device in the line*
$\lambda=0{\cdot}013$ $R_D>500{,}000$
(*a*) 20 *diameters upstream*
$\alpha=1{\cdot}05$ $V_{mean}/V_{centre}=0{\cdot}806$
(*b*) 10 *diameters downstream*
$\alpha=1{\cdot}044$ $V_{mean}/V_{centre}=0{\cdot}828$
(*c*) 20 *diameters downstream*
$\alpha=1{\cdot}041$ $V_{mean}/V_{centre}=0{\cdot}835$
(*d*) 40 *diameters downstream*
$\alpha=1{\cdot}037$ $V_{mean}/V_{centre}=0{\cdot}841$



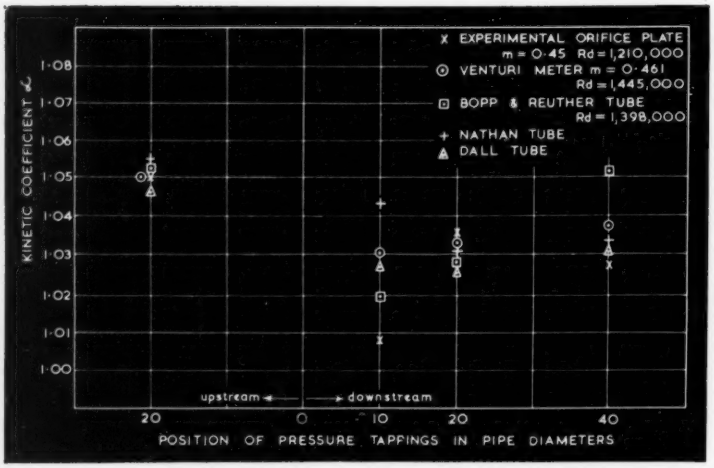
The experimental orifice plate on the other hand does preform the flow, but it has no divergent cone. The result is a major change to velocity distribution which resolves only slowly so that at a distance 40 diameters downstream, the kinetic energy coefficient and the ratio V_m/V_c are only just returning to their original values. Thus as a side comment it can be observed that a condition which is advantageous from the point of view of good coefficient characteristics becomes a disadvantage to efficient pressure recovery.

So far we have been able to show that the disturbance to the pressure/velocity balance created by primary elements does persist for a considerable distance downstream which is certainly in excess of 20 pipe diameters. As far as the plane of identity is concerned, it should be remarked that the test is whether the shape of the curve at any given point downstream, the value of the ratio V_m/V_c, and the value of the coefficient α, are those applicable to undisturbed or properly developed flow in the pipe. Repetition of this point is made because it does not necessarily follow that, for example, V_m/V_c of the downstream profile at the plane of identity will correspond to that upstream of the primary element. Rather will it be that which corresponds naturally to the pipe length in which the plane of identity occurs.

To underline this, the pipeline for this series of tests was made up of pipe lengths which were not of uniform roughness. Moreover, the pipe roughness before each device was changed for some tests; those on the Bopp and Reuther tube, for example, were made with smooth pipe $\lambda = 0{\cdot}017$ upstream and downstream, whereas those on the Dall and Nathan tubes were made with upstream pipe having $\lambda = 0{\cdot}013$. This pipeline had characteristics as shown on Fig. 7. It would be wrong to expect that the ratio V_m/V_c for $\lambda = 0{\cdot}017$ would be the same in a pipe having a different value of λ. This is one reason to modify the common method of obtaining the pressure losses due to the primary element alone.

Fig. 8. *Variation of kinetic coefficient* α *with position of pressure tappings*

$R_d > 1{,}200{,}000$



Methods for Obtaining Pressure Losses

This method is expressed by the simple equality:

$$\triangle H_\tau - (h_{fu} + h_{fd} + h_{pe}) = \triangle H_{pe} \quad \ldots\ldots\ldots (1)$$

where: $\triangle H_\tau$ = total pressure loss between upstream and downstream tappings, including the differential produced by the primary element

h_{fu} = friction pressure drop in pipe between upstream tapping and the primary element

h_{fd} = friction pressure drop in pipe between the primary element and the downstream tappings

h_{pe} = the friction drop in a piece of pipe of equivalent length to the primary element (negligible for thin plate orifices, even if in a carrier)

$\triangle H_{pe}$ = irrecoverable pressure loss caused by the primary element alone.

The second reason is closely linked with λ, V_m/V_c and profile shape, and is the variation in the kinetic energy coefficient α. The change in values of α with location of downstream traverse or pressure tapping is shown on Fig. 8. It follows that in the above equation (1) $\triangle H_\tau$ would be subject to α corrections corresponding to the profiles at the upstream and downstream tappings. Likewise h_{pe}, h_{fu}, h_{fd} which are functions of $V^2/2g$ would also be subject to similar corrections, but of different values.

At this stage, consequently, equation (1) should be written:

$$\phi\,(\alpha_1 \triangle H_\tau) - [\phi(\alpha_2 h_{fu}) + \phi\,(\alpha_3 h_{fd}) + \phi\,(\alpha_4 h_{pe})] = \triangle H_{pe} \quad \ldots\ldots\ldots (2)$$

where: α_1, α_2, α_3, and α_4 would depend upon profile conditions for the lengths of pipe mentioned in the above definition of symbols.

Furthermore, h_{pe}, h_{fu}, h_{fd} can only be obtained by assuming that there is uniform flow and a known constant friction coefficient λ for each of the three pipe sections. But these conditions do not occur when the primary element is in position.

In the section of pipe which gives h_{fu} there is before the device a slight acceleration of flow; in the section after the device which causes h_{fd} there is decelerating flow. (The profiles show for how long!) The regime in the small section giving h_{pe} is unimportant.

Very little information seems to be available about friction coefficients for non-uniform flow, but a paper[1] has recently been written which gives valuable guidance as to the trends to be expected. The title gives a clear indication of the contents and detailed discussion here is neither possible nor necessary.

Four extracts however are pertinent:

EXTRACT 1. *Page* 1077:

" In the case of the uniform diameter conduit, the magnitude of the boundary resistance during accelerated flow is very nearly the same as for the equivalent steady motion. Nevertheless, in Fig. 7 (our Fig. 9 (d)), there is a definite indication that K_u/K_s is greater than unity.

where: K_u = unsteady flow coefficient of boundary resistance and momentum flux of absolute local velocity

K_s = one-dimensional steady-state " resistance" coefficient.

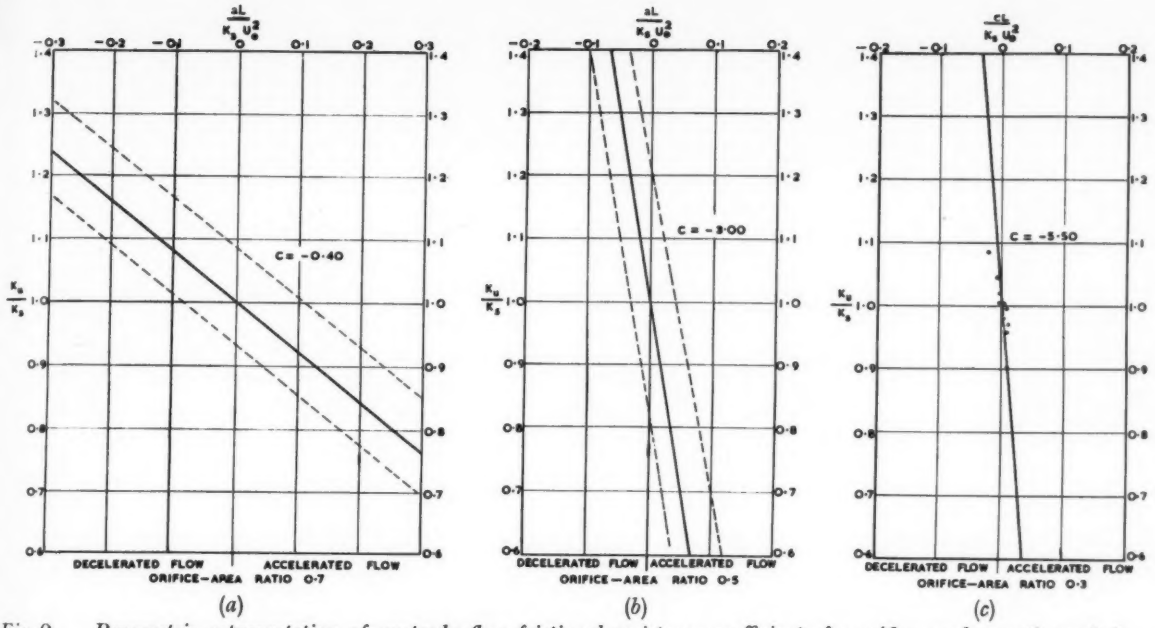


Fig. 9. Parametric representation of unsteady flow frictional resistance coefficients for orifices and smooth conduits

$\frac{aL}{K_s U_o^2}$ *is an acceleration or deceleration parameter*

where $a = \frac{\partial U_o}{\partial t}$ = *acceleration of mean flow in conduit*

L = *conduit length*

$K_u = \frac{F}{\rho U_o^2 A/2} + 2[(\beta_2 - \beta_1) + (I_2 - I_1)]$ ·

F = boundary resistance, wall shear, etc.

$\beta = \frac{\int_o^A u^2\,dA}{U_o^2 A}$ a distribution factor for mean velocity

$I = \left(\int_o^A u'^2\,dA + 2\int_o^A uu'\,dA\right) \Big/ U_o^2 A$ a distribution factor for turbulent fluctuations

$U_o = \frac{Q}{A}$ u' = fluctuating flow velocity

u = mean flow velocity

$U = u + u'$

and $K_s = f_s \frac{L}{D}$

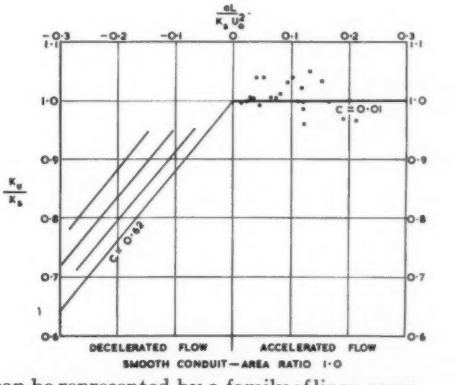
where: $f_s = \phi\lambda$ = steady state friction factor

It follows that $K_u/K_s > 1$ means an increase in resistance compared with that for the steady state.

Thus the case of resistance due to boundary-layer shear stresses is affected differently by unsteadiness than resistance associated with the turbulence generation and diffusion accompanying separation and jet formation."

EXTRACT 2. *Page* 1077.

" For decelerated flow the boundary resistance of the uniform tube is less than for steady flow. As shown,



(*d*)

these data can be represented by a family of lines, essentially parallel, one from each deceleration. At any particular velocity, the proportion of boundary resistance to over-all potential drop is different, decreasing with increasing deceleration. All of these runs were started from the same steady-state velocity, but included different initial impulse periods. From the parallel displacement of the lines for different decelerations, it appears that the flow conditions of the subsequent established phase depend on the previous flow history.

These observations for the uniform tube are consistent with the view that under acceleration the central portion of the stream moves somewhat bodily while the velocity profile steepens, giving higher shear. For deceleration, the reverse seems to hold. In either event, it appears that unsteadiness does not result in marked changes from equivalent steady-state flows."

EXTRACT 3. *Page* 1077.

The authors noted: " For decelerated flow through the smaller orifices, it was observed that as the unsteady

run proceeded the magnitude of the potential drop changed from less than the equivalent steady-state drop (as required to establish the deceleration) to more; i.e. K_a/K_s became greater than 1·0 as the test run proceeded. For acceleration through the 0·3 orifice, there was some indication that a corresponding change to $K_a/K_s < 1{\cdot}0$ occurred late in the run."

$$K_a = \frac{p_1 - p_2}{\rho\, U_o^2/2}$$ Unsteady flow coefficient of total drop in potential

EXTRACT 4. *SUMMARY Page* 1077.

" In summary, it is concluded that the imposition of an unsteady transient produces different effects for the two basic types of flow investigated, as follows:

1. For cases of surface resistance caused by boundary shear stresses
   (a) With acceleration the resistance is slightly, but not appreciably, greater than for the equivalent steady state
   (b) With deceleration the resistance is appreciably less than for the equivalent steady state
   (c) With either acceleration or deceleration, it appears that the internal flow structure is not markedly different from that for steady states
2. For cases of form-type resistance associated with the high shear and generation and diffusion of turbulence accompanying jet formation
   (a) With acceleration the resistance is appreciably less than for the equivalent steady state
   (b) With deceleration the resistance is appreciably more than for the equivalent steady state
   (c) For intense jet action as obtained with small orifice-to-tube-diameter ratios, it appears that unsteadiness produces an internal flow structure that is no longer comparable to any steady-state condition."

These are formidable conclusions, when, from the photographs reproduced here as Fig. 9 of Figs. 4 to 7 of their paper, the variations in K_u/K_s are seen to be of significant magnitude.

It becomes necessary to re-write equation (2) thus:

$$\phi\,(\alpha_1 \triangle H_\tau) - [\phi\,(K_u/K_s, \alpha_2 h_{fu}) + \phi\,(K_u/K_s, \alpha_3 h_{fd}) + \phi\,(\alpha_4 h_{pe})] = \triangle H_{pe} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

It seems that this equation cannot be evaluated correctly and completely until more work on friction coefficients for accelerated and decelerated flow has been done along the lines of this A.S.M.E. paper.

Under these circumstances, it is already apparent that attempts to give absolute values of pressure loss, due to a primary element, expressed as a percentage of differential head must fail. Such values may well be in error to an extent which precludes any attempt to represent apparent marginal improvements in pressure recovery of this or that development as an economic advantage.

The reader may remember that in a previous article, this method of stating pressure loss was criticised in another way on the grounds that it, in effect, related pressure loss to coefficient of discharge via area ratio!

Equation (3) could now be re-written:

$$\phi\,(\alpha_1 \triangle H_\tau) - [\phi\,(K_u/K_s, \alpha_2 h_{fu}) + \phi\,(K_u/K_s, \alpha_3 h_{fd}) + \phi\,(\alpha_4 h_{pe})] = \triangle H_{pe} = \phi\,(C, \alpha, R_d, m) \quad \ldots\ldots\ldots (4)$$

These arguments lead back to the use of a plane of identity insofar that evaluation or interpretation of results become possible only when the various corrections stated in equation (4) can be ignored or are equal to unity, or obtained on the assumption that a steady-state has been restored.

The location, in multiples of pipe diameter, of this plane can be obtained by inspection of the velocity profiles given in Figs. 2–6 and will be decided by considering the values of α and V_m/V_c.

Effect of Each Device

Having now decided at what point comparisons are possible, it is preferable to show the effect of each device

TABLE I

$1{,}000{,}000 < R_d < 1{,}400{,}000$

Variation in total energy with tapping position

$$\mu = \frac{\text{Total energy at any position}}{\text{Total energy 20 diameters upstream}}$$

Type of Device	Values of μ at each downstream tapping			Plane of Identity
	10 diameters	20 diameters	40 diameters	
Nathan Tube	0·870	0·855	0·723	40
Dall Tube	0·874	0·861	0·757	40
Bopp and Reuther Tube	0·926	0·900	0·814	40
Venturi Tube	0·826	0·813	0·714	40
Experimental Orifice Plate	0·632	0·597	0·567	40
No device in pipe	0·895	0·861	0·795	

Tests on the Dall tube using a position 5 diameters downstream give a value $\mu = 0{\cdot}900$.

Percentage decrease in energy available at the 40 diameters position due to installation of primary element:

Dall Tube:	4·8%
Nathan Tube:	9·1%
Bopp & Reuther Tube:	8·0%*
Experimental Orifice Plate:	36·5%
Venturi Tube	10·4%

*This is obtained from the information for a uniform water pipe and not from Table I.

NOTE—The figures in Table 1 and above are slightly dependent upon Rd variation but trends are similar.

on a basis of total energy suitably corrected for velocity distribution and roughness.

Table I and Fig. 10, give this information for both the plane of identity and for the other test positions as well.

In all cases it is clear that the velocity profile development which occurs downstream of the devices (more than arbitrary position of tappings) has some influence on the energy loss fraction.

Comparison of Figs. 10–14 underlines this point. The curves of Fig. 10 in some cases show marked variation in total pressure drop with axial position. Analysis of these data involves both α and V_m/V_c.

The variation of α with position (Fig. 8) is worst at 10 diameters: the scatter of test points is fairly wide and is opposite in this respect to the curves on Fig. 10 which close up at 10 diameters.

The variation of α with V_m/V_c is naturally more orderly. In fact, the average gradient of the assembled test points for all devices is not so much different from the natural gradient or theoretical relationship expected. Notably the experimental orifice plate gradient is an isolated case. The limited scatter of pressure loss with V_m/V_c (Fig. 12) is in contrast to the marked and more

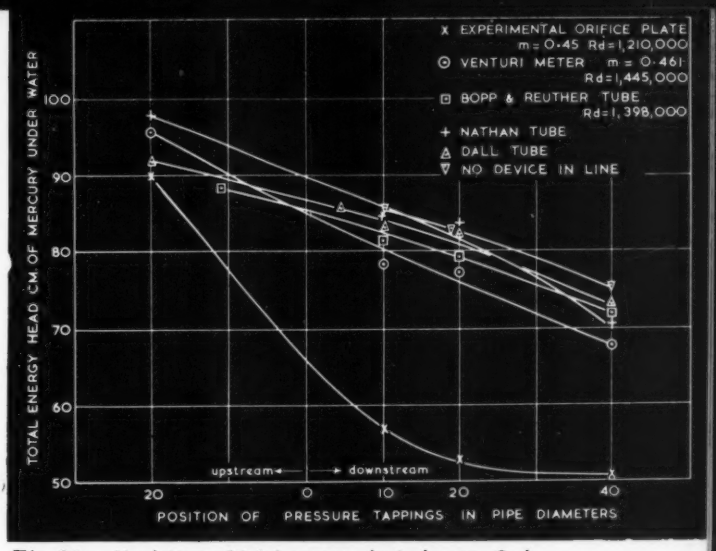


Fig. 10. Variation of total energy drop in an 8 in. water line with position of pressure tapping $R_d > 1{,}200{,}000$

stream is reached. The exception is the Dall tube for which the values of V_m/V_c only rise for a short period between positions 20 diameters and 40 diameters

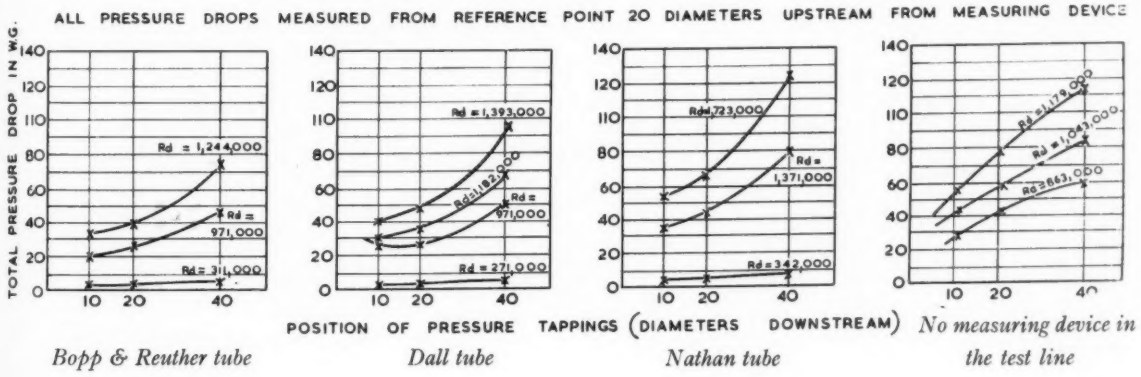


Fig. 11. Variation of total pressure drop in an 8 in. water line with position of pressure tappings

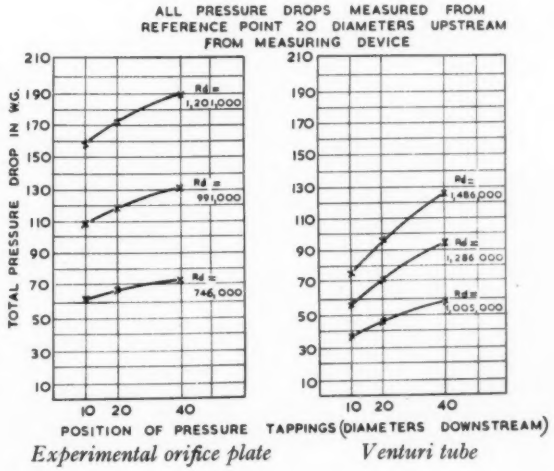
revealing scatter of the total energy with V_m/V_c (Fig. 14). It is clear that any attempt to evaluate losses which ignore the implications of Figs. 8 and 13 will be unsatisfactory. These two curves verify that true energy loss is bound up with velocity distribution. Further, they imply that energy losses will vary if the device is installed in a pipe in which there is undeveloped distribution, or in which the downstream distribution is not allowed to resolve naturally.

Differences between Air and Water Tests

At this point, it is interesting to note the differences between the air and water tests.

Reference to Fig. 1(a) shows that in a pipeline of uniform roughness, these flow tubes cause only limited changes to V_m/V_c and that the values of this ratio downstream of the device are little different from that applicable to the undisturbed conditions upstream.

It is noticeable that, in most cases, the value of V_m/V_c increases until a position 10 diameters down-


ALL PRESSURE DROPS MEASURED FROM REFERENCE POINT 20 DIAMETERS UPSTREAM FROM MEASURING DEVICE
TOTAL PRESSURE DROP IN W.G.
Rd = 1,201,000
Rd = 991,000
Rd = 746,000
Rd = 1,486,000
Rd = 1,286,000
Rd = 1,005,000
10 20 40
POSITION OF PRESSURE TAPPINGS (DIAMETERS DOWNSTREAM)
Experimental orifice plate
Venturi tube

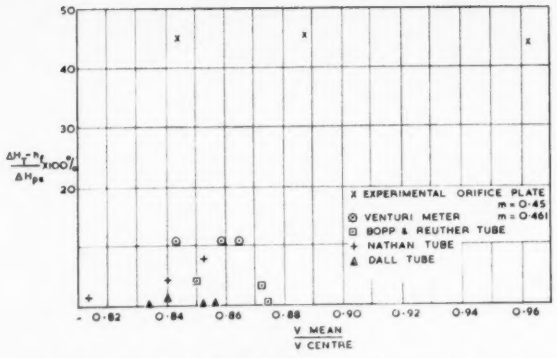


Fig. 12. The variation with V_{mean}/V_{centre} of irrecoverable pressure loss as a percentage of differential head

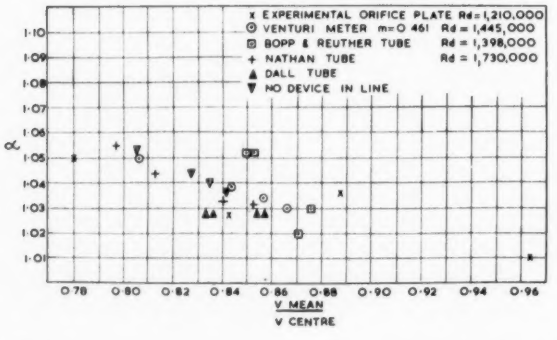
downstream, and for which there is a maximum deviation V_m/V_c of about 1%.

If now reference is made to the water tests, Fig. 1(b), which were made using an upstream pipe with a roughness different from that downstream, there appears to be the same general characteristic of V_m/V_c versus axial position as before.

There are differences which require comment, the first is that the values of V_m/V_c as the distribution resolves are, for the downstream positions, clearly dependent upon the downstream pipe characteristic alone; the second is that the influence of the upstream pipe characteristic not only affects the V_m/V_c gradient of the test line alone, i.e., without a device installed in it, but in addition causes the changes in V_m/V_c downstream of a device to be more pronounced. Using the Dall tube as an example, the change of 1% in a uniform pipe system becomes $2\frac{1}{2}$% between the 5 diameters and 20 diameters positions.

As a second example, the experimental orifice shows these effects more drastically. With a uniform air pipeline there is a change in V_m/V_c values of $5\frac{1}{2}$% with a maximum at the 20 diameters downstream position. In the non-uniform water pipeline, this change becomes 20% with a maximum at the 10 diameters position. In part this change is due in a very limited degree, perhaps 3%, to the fact that the experimental orifice plate

Fig. 13. Variation of kinetic coefficient α with V_{mean}/V_{centre} in an 8 in. water line


X EXPERIMENTAL ORIFICE PLATE Rd = 1,210,000
VENTURI METER m = 0·461 Rd = 1,445,000
BOPP & REUTHER TUBE Rd = 1,398,000
NATHAN TUBE Rd = 1,730,000
DALL TUBE
NO DEVICE IN LINE
α
V MEAN / V CENTRE

tested in the water line had a slightly smaller area ratio than that used for the air tests.

Nevertheless, between 10 diameters and 40 diameters downstream the V_m/V_c value falls rapidly to that appropriate to the undisturbed flow condition in the downstream pipe.

Since these comparisons consist of one set of tests under uniform pipe conditions using air and one set under non-uniform conditions using water, it could be argued that the test media is or could be responsible for the variations noted.

Therefore, the results for the Bopp and Reuther tube should be considered again in the present context. These tests were made in a *uniform water* line and they repeat, very clearly, those made in the uniform air line.

It is reasonable to assert that the pipeline characteristics upstream and downstream of a primary element have an influence on pressure recovery or total energy losses. Moreover, these tests show that the 10 diameters downstream position usually chosen to obtain this information is unrepresentative and must give unreliable information.

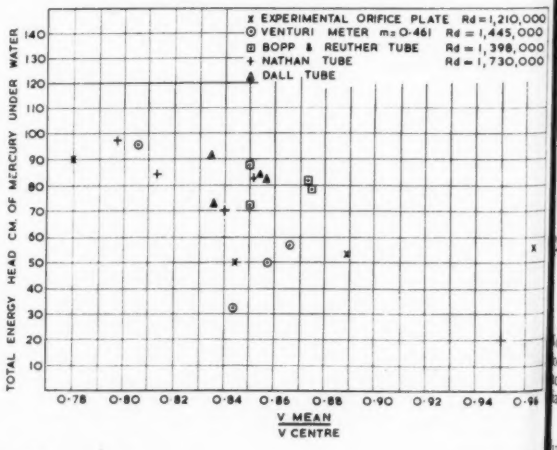
In the examples above, the Dall tube has, apparently, at 5 diameters downstream a low V_m/V_c value equal to that at 40 diameters. It is for these positions that Miner[2] quoted a loss for a Dall tube m = 0·607 as $2\frac{1}{2}$% of differential head. Whereas the present tests give less than 1% of differential head.

This is fortuitous and in view of the subsequent rise in V_m/V_c values between the 5 diameters and 20 diameters positions which show that tube is still affecting the system, it would be premature to assume that the losses at the 5 diameters point are the true losses imposed on a system by the installation of one of these devices.

Table I also shows the reductions in total energy which occur along the pipe as a result of the installation of these primary elements.

In the event the differences at distances not less than 20 diameters are, alone, those which are worth discussing in terms of the economics of flow metering since they occur around or after the plane of identity.

Fig. 14. Variation of total energy head with V_{mean}/V_{centre} in an 8 in. water line


X EXPERIMENTAL ORIFICE PLATE Rd = 1,210,000
VENTURI METER m = 0·461 Rd = 1,445,000
BOPP & REUTHER TUBE Rd = 1,398,000
NATHAN TUBE Rd = 1,730,000
DALL TUBE
TOTAL ENERGY HEAD CM. OF MERCURY UNDER WATER
V MEAN / V CENTRE

It is obvious from the table that no reliance can be placed on information of the sort given for the 20 diameters position where the Nathan and Dall tube appear to give virtually no losses at all.

Table II shows the differences which result when the energy loss fraction is compared with the same data presented in conventional form, see equation (1), and Fig. 15, as a percentage of the differential head created by each device. The reader should bear in mind equations (1) to (4) and recall that data given in

TABLE II

$R_d > 1{,}000{,}000$

Comparison of losses based on total energy and as a percentage of differential head

NOTE—These percentage differences are obtained using the Venturi tube as a datum

Type of Device	Position of tapping (diameters)	Differences (Device loss—Venturi tube loss) % Differential Head Basis	Total Energy Basis
Nathan Tube	10	− 10·0	− 4·5
Dall Tube		− 10·3	− 10·5
Bopp and Reuther Tube		− 7·0	− 11·9
Experimental Orifice Plate		+ 33·5	+ 23·5
Nathan Tube	20	− 10·0	− 5·5
Dall Tube		− 10·0	− 11·5
Bopp and Reuther Tube		− 10·0	− 11·2
Experimental Orifice Plate		+ 35·0	+ 25·8
Nathan Tube	40	− 6·0	− 7·3
Dall Tube		− 9·0	− 11·0
Bopp and Reuther Tube		− 6·0	− 14·2
Experimental Orifice Plate		+ 34·0	+ 20·5

EXAMPLE

(1) The loss measured at 10 diameters downstream expressed as % differential head of the Nathan tube is 10% less than for a Venturi tube of equivalent area ratio, but in total energy terms it is only 4·5% less.

(2) Similarly, the loss as % differential head of the experimental orifice plate is 33·5% more than a Venturi of equivalent area ratio. In total energy terms it is 20·5% more.

NOTE—Tests on the Dall tube using a position 5 diameters downstream show that the loss as a percentage of differential increases slightly so that the figure in the above table for 10 diameters is reduced by about 1%.

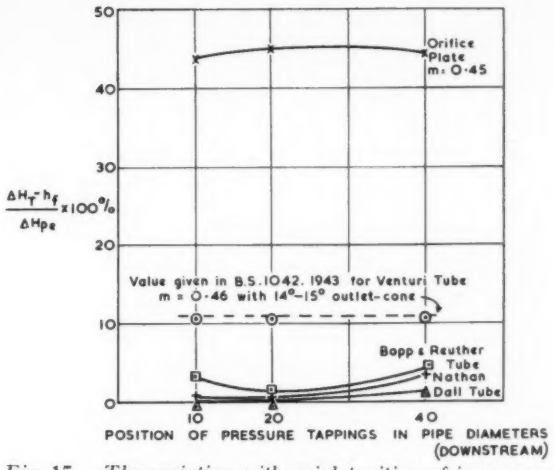


Fig. 15. The variation with axial position of irrecoverable pressure loss as a percentage of differential head $R_D > 500{,}000$

conventional presentation can easily be in error due to variations in friction coefficients under accelerating but mostly decelerating flow.

The Venturi tube line has been used as a reference, and as this has a smaller area ratio (m = 0·45) the comparisons are therefore relative. However, the pressure and energy losses for Venturi tubes up to m = 0·6 remain constant and independent of Reynolds number, so that these relative figures come very near to absolute comparisons.

But ignoring the arguments for or against methods of presentation, it is surprising to note that no device causes less than 4·8% loss of total energy and that even a medium high area ratio Venturi tube will cause as much as 10·4% loss.

Mechanism of the Efficiency of Bopp and Reuther and Dall Tubes

Since these results show that the Bopp and Reuther and Dall tubes are the most efficient, or cause the smallest energy losses, some attempts were made to understand by what means this is achieved. Miner[2] and others have suggested that the marked static depression, amounting for much of the flow range to a suction, exercised some form of boundary layer control.

However, both the data in this article and other published information shows that the Dall tube irrecoverable losses are constant and reasonably independent of Reynolds number.

If the percentage loss is dependent upon the throat static depression, it follows that either for a constant loss percentage this depression remains constant and independent of Reynolds number, or that the percentage loss must vary in value with variation in throat static.

The first proposition is, of course, absurd and can be eliminated. To confirm the second, a series of tests were made to relate throat and differential pressure. These results are shown on Fig. 16. A variation in throat pressure condition of this magnitude when it is known that the loss fraction is almost constant seems

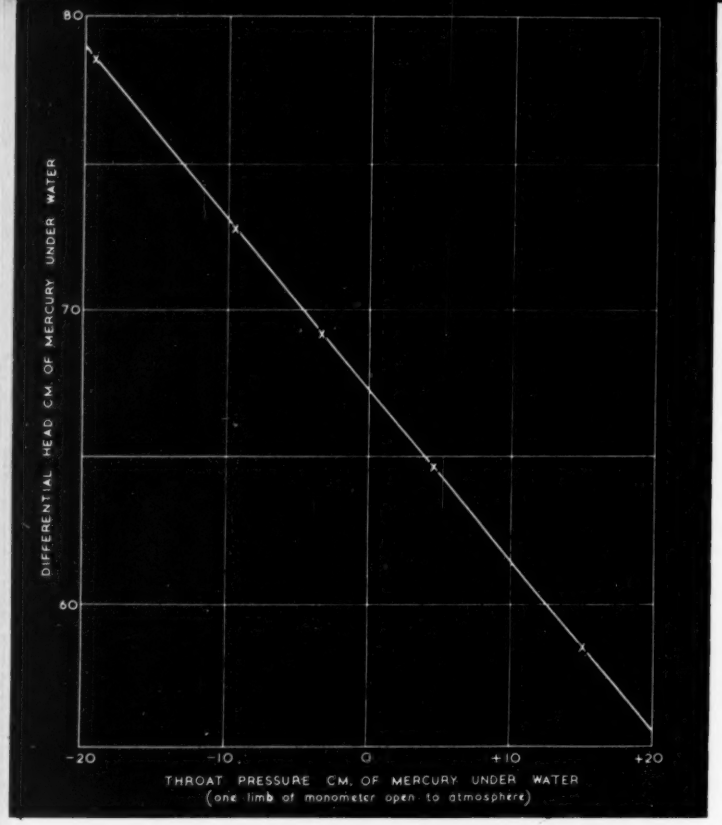


Fig. 16. Variation of throat pressure with differential head of a Dall tube in an 8 in. water line $m = 0{\cdot}607$

to rule out the theory that conditions at the plane of the throat tapping have anything at all to do with the mechanism of pressure recovery.

In another test the overall pressure loss between points 20 diameters upstream and 20 diameters downstream was read on a manometer at a flow rate which gave a suction condition at the throat tapping. Then the throat was pressurised sufficiently to balance the suction condition. In other words, an attempt was made to fill up any separation cavities which might exist. This trial produced no change whatever in the overall loss reading at any pressure or filling rates.

The reverse of this test was then tried by an attempt to draw the fluid stream in the throat out to the boundaries by suction means. This again produced no change in the overall loss.

Finally, all four throat tappings were opened to atmosphere, so that ingress of air could occur. This unnatural condition caused an increase in overall loss of about 3%, which figure seemed to be independent of Reynolds number for $R_d > 1{,}000{,}000$. Therefore, it seems valid to suppose that throat pressure conditions have nothing to do with pressure recovery at all.

It is more likely that the velocity profiles given in Figs. 3 and 4 provide the answer for they show that the geometry of both the Dall and Bopp and Reuther tubes causes only a slight modification to the velocity distribution as it exists upstream of the device.

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Instrument Ball Bearings

By P. J. Geary, M.Sc.(Eng.)

The use of small and miniature ball bearings of precision grade in instruments and in other apparatus such as electric motors, machine tools, and domestic appliances is becoming rapidly more widespread. During the last ten years in particular, the production of these instrument ball bearings has increased enormously, while at the same time refinements in the techniques of their manufacture have made available bearings of greatly enhanced performance.

This survey of instrument ball bearings constitutes the fourth section of the Survey of Instrument Parts being carried out by the British Scientific Instrument Research Association, and offers a concise review of the characteristics of bearings, and their utilisation with reference to 144 cited literature sources.

The topics dealt with include types and grades of bearing; tolerances; truth of running; avoidance of vibration and noise; frictional torque; performance measurements; handling; mounting; lubrication; internal clearance; preloading and elimination of play; deflection under load; and load capacity and life.
80 pages. 13 line diagrams. Name index. Price 21s. in U.K. (23s. 6d. abroad).

X-ray Analysis Research

The most recent developments in X-ray analysis are discussed in Volume 4 of "Advances in X-ray Analysis", published by the University of Denver. This addition to the series contains the complete texts of 38 reports presented at the Ninth Annual Conference on Applications of X-ray Analysis held August 10-12, 1960, in Denver, Colorado, and sponsored by the University of Denver.

Volumes 1-3 of "Advances in X-ray Analysis" contain the proceedings of the 1957, 1958, and 1959 conferences. This continuing series provides a valuable reference both to the research worker engaged in X-ray analysis and to the beginner who needs to develop competence quickly. All the volumes are available from Plenum Press, New York.

"Advances in X-ray Analysis", Volume 4, contains discussions of theory and new instrumentation, combined with data on the most important applications of the method. Papers dealing with crystal structure are correlated with new techniques for trace analysis of minerals. Electron probe research, X-ray microscopy, geological morphology, phase transformation in refractory alloys, and studies at cryogenic and at extremely high temperatures are among the subjects covered by the papers.

CALIBRATION OF PLATINUM RESISTANCE THERMOMETERS

The International Practical Temperature Scale (IPTS) is defined over the range −182·97 to +630·5°C in terms of a platinum resistance thermometer. The National Bureau of Standards, by calibrating standard platinum resistance thermometers for science and industry, contributes to the accuracy and uniformity of temperature determinations, both on the IPTS and on the NBS scale from 10 to 90° K.

THERE is a growing need in all branches of science and technology for temperature measurements of increased accuracy and precision. This is true not only over the usual range of temperatures, but in the more extreme temperature regions as well. Platinum resistance thermometers, which can be used over a wide range of temperatures with great effectiveness, help to fill this need.

Permissible Types of Thermometer

Although there are many types of resistance thermometers, employing a variety of materials, the Bureau specifies that only thermometers having a 4-lead resistor of very pure platinum, hermetically sealed in a protecting tube, be submitted for calibration.[1] Resistance thermometers are made in three general forms: long-stem, capsule, and calorimetric. The sensing element in the long-stem and capsule types consists of a fine helix of platinum wire wound bifilarly on a supporting frame of mica. The winding is supported by notches in the mica frame in such a manner as to leave the wire as strain-free as possible. Near each free end of the coil is attached an additional short platinum lead wire, making the sensing element a 4-lead resistor. The coil is protected by enclosure within a gas-filled case.

The capsule thermometer is short, about two inches in length, and has a platinum case. The lead wires go out through an air-tight glass seal, and the capsule is filled with a mixture of helium with 2% oxygen. As the entire capsule, including the glass seal, is at the temperature being measured, and because glass becomes significantly conducting at high temperatures, this type of resistance thermometer is not normally used above 300° C.

The stem-type resistance thermometer is usually about 18 inches long, although the resistance coil is quite small. The short platinum leads of the resistor are attached to four gold extension wires, and the entire assembly is enclosed within a glass cylinder containing dry nitrogen and 2% oxygen. Because of the length of this device, the point where the wires go out through the case is at room temperature, and stem-type thermometers are often used to 500°C if encased in glass and to 630·5°C and above if enclosed in quartz.

The third type of platinum resistance thermometer, used in calorimetric measurements, has a coil wound on a flat strip of mica which is encased within a thin metal sheath. The case is filled with dry air. This type of construction has the advantage of rapid thermal response, which is an advantage for some types of calorimetric determinations.

Capsule-type resistance thermometers are calibrated at temperatures as low as 10°K (−263°C) but, because of the electrical conductivity of the glass at high temperature, they are usually not calibrated at the sulphur point. Thermometers of the stem type are calibrated at the boiling points of oxygen (−182·97°C), water, and sulphur (444·6°C), and at the triple point of water (0·01°C), and those of the calorimetric type are calibrated at the triple point, steam point, and near 50°C. The capsule- and stem-type thermometers are annealed before calibration by being placed in the re-entrant wells of the sulphur boiler for four hours.

Resistance Measurement

The resistance of the thermometer being calibrated is measured with a Müller-type bridge. Readings are taken to the nearest ten micro-ohms, with a current of two milliamperes flowing in the thermometer. In most cases, the heating effect of this current can be ignored if the thermometer is used with this same current. However, if the thermometer is to be used under conditions where the thermal contact is poor or variable, errors which might arise from the heating effect can be minimised if all (calibration and actual use) resistance readings are taken with both two and five milliamperes flowing in the thermometer, and the resistance at zero current found by extrapolation. To eliminate the resistance of the lead wires attached to the platinum resistor, readings are made with two combinations of bridge-lead connections and the resistance of the coil alone is then the average of the two readings.

Low-temperature Calibration

Over the range of 10 to 90°K, capsule-type resistance thermometers are calibrated in a hydrogen bath against one of the standard resistance thermometers maintained by the Bureau. Both the test and standard thermometers are inserted into a copper block, and the necessary connections are made. This aggregate is then placed within the cryostat. The system is sealed from the atmosphere by soldering an airtight canister to the stationary cover with Woods metal. The temperature within the cryostat is controlled at temperatures below 20°K by adjusting the pressure on the liquid hydrogen refrigerant within the cryostat. At temperatures above 20°K, the temperature is controlled by electrically heating the block to achieve the desired temperature and then heating the shield to maintain this temperature. A control system, actuated by a multiple-junction thermocouple between the copper block and the shield, maintains the temperature within

narrow limits. After thermal equilibrium is achieved at each calibration temperature, several simultaneous resistance readings are taken on each thermometer and the standard.

A second cryostat is used for the calibration of both capsule- and stem-type resistance thermometers at the oxygen point (−182·97°C). Once again, a comparison is made with a standard resistance thermometer. Because the thermometers are inserted in long re-entrant wells, a lead-wire assembly must be attached to capsule-type thermometers, and a glass protection tube is slipped over both the thermometer and lead wires. Liquid nitrogen is used to cool the cryostat, and a heating coil, controlled automatically as in the hydrogen bath, is used to maintain the temperature at the oxygen point. Several readings are taken for each thermometer at the oxygen point.

Triple Point Calibration

Although the triple point of water (0·01°C) was not adopted as defining a fixed point on the International Practical Temperature Scale[2] until 1960, the Bureau has been using triple point cells in calibration activities for many years. The cell consists of a sealed glass cylinder nearly filled with pure, air-free water. A re-entrant well is provided for the insertion of a thermometer. In use, the cell is cooled by immersion in an ice bath, and a mantle of ice is formed around the re-entrant well with dry ice. After a sufficient mantle has formed it is freed from the glass by slight warming from within the well, to provide an immediately adjacent water-ice interface. The thermometer is then inserted into the well, using an aluminium bushing for good thermal contact. Resistance readings are then taken after equilibrium is achieved. To check on the stability of a thermometer during calibration, the resistance at the triple point is determined before and after measurement at any of the other fixed points.

Steam and Sulphur Point Calibration

Special boilers, operating in a closed system in which the pressure can be closely regulated, are used to reproduce the steam (100°C) and sulphur (444·6°C) points.[3] Helium gas is employed to transmit the pressure to a precision manometer. The boilers are cylindrical, with re-entrant wells extending from the top into the vapour region. The water boiler was constructed of copper, heavily tinned on the inside to prevent contamination, and the sulphur boiler was made of 2S aluminium. At the bottom of each boiler is a re-entrant dome, inside of which is placed an electric heater. Tangentially to the dome, and within the boiler, are positioned vertical silver (water boiler) or aluminium (sulphur boiler) wires which prevent explosive boiling. Radiation shields are placed within the boilers to isolate the re-entrant wells from the boiler walls and heating zone. The vapours are condensed at the top of the boiler by means of water-cooled jacket. The level of the helium-vapour interface, which must be known for the determination of pressure, is measured with thermocouples placed within the walls of the condenser.

The water boiler reaches thermal equilibrium quite rapidly, but experience has shown that temperature changes occur within the sulphur boiler for some time. Therefore, calibrations are not started until the sulphur has boiled for at least ten days.

Other Services

The Bureau also calibrates calorimetric-type resistance thermometers. This calibration is accomplished by determining the resistance at the ice and steam points, and at a third point near 50°C. A stirred water bath, in which the test thermometer is compared with a standard thermometer, is used for the latter point.

Also, the resistance of platinum wires such as are used in thermocouple construction is determined at the triple and steam points. The resistance at 0°C is then computed, and the ratio of the resistances at zero and one hundred degrees (R_{100}/R_0) is determined. This ratio must exceed 1·3920 to meet the specifications of the International Practical Temperature Scale.

Certification

Certificates containing the appropriate constants for use in the specified interpolation equations are prepared for each thermometer submitted for calibration. Separate tables, which relate resistance to temperature at 0·1 degree (capsule type) or 1·0 degree (all other types) intervals, are also prepared. All values are derived from the raw data by a high-speed computer.

Research

Research is being conducted in several areas to extend the accuracy and range of platinum resistance thermometers. A thermometer has been constructed, consisting of platinum threaded through holes drilled in synthetic sapphire discs, and has been found to drift less than 0·001°C/hr at 1000°C.[4] Further development of resistance thermometers for use at high temperatures may eventually lead to the extension of the defining range of these thermometers on the International Practical Temperature Scale to 1063°C. The present limit is 630·5°C.

Effort is being made to put the calibration procedure on a more automatic basis. Read-out devices are being incorporated to permit automatic recording of all raw data which will facilitate communication with the computer. Plans have been made to permit the oxygen bath to be connected to the precision manometer and which will provide, directly, a defining fixed point temperature (−182·97°C). Plans are also being made to construct an apparatus for the calibration of resistance thermometers at the zinc point (419·505°C). This temperature, which is more reproducible than the sulphur point, has been accepted as an alternative to the sulphur point in the 1960 text of the IPTS.

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Electrochemical Means for Rapid Analysis of Metals*

By HUGH C. McINTYRE, M.C.I.C

IN the complex purification processes of modern metallurgical plants, there is an urgent need for quick, accurate, instrumental methods of analysis and the resources of electrochemistry, long applied in the research laboratory, are being streamlined and fool-proofed for plant applications. Three such developments were recently discussed at a symposium in Montreal, Canada, held jointly by the Chemical Institute of Canada and the Instrument Society of America, on instrumental methods of analysis.

All three methods provide fast, reproducible analysis using electric and electronic techniques to give recorded results within minutes for better process control and release of chemists from messy, routine analytical chores. Two are Canadian, the products of Cominco (Consolidated Mining and Smelting Co. of Canada) and the Canadian Bureau of Mines instrument research. Both use the principles of polarography to speed wet analysis. The other is U.S., a Union Carbide Nuclear development, which uses oscillometry to analyse solid samples for UO_2.

Principles of Polarography

The basic technique of polarography is simple: an electrolytic cell in which the change in current with applied voltage is measured. If the cell solution contains, say, cadmium ions, very little current flows until 0·65 V potential is reached, when the cadmium ions will be able to accept electrons from the cathode. The size of the current at this voltage indicates concentration, while the voltage identifies the ion involved. If a number of reducible ions are in solution, the current (I) rises in a series of steps. The voltage at which each step reaches half the total current increase is known as the half-wave potential (E 1/2).

The art of polarimetry consists in refining circuits to get exact and reproducible measurements of small changes in current and voltage, and also in preventing any degree of polarisation of the cathode. The dropping mercury electrode (DME), a series of fine drops emerging from a capillary of about 0·05 mm diameter, is often used to solve the polarisation problem.

However, the refinements necessary to get accurate, reproducible measurements made the conventional polarograph primarily a laboratory instrument requiring a skilled operator, and restricted in use to single samples. In plant practice, therefore, simplified assay techniques were usually employed on the floor, to get rough results later to be confirmed by the laboratory polarograph.

Cominco's Process Polarograph

W. K. Gowans, of Cominco's Trail, B.C., plant, described the development of a process stream polarograph designed to provide a continuous recording of the concentration of cadmium in the electrolyte before final addition of purifying agents.

In analytical techniques, the difference in current obtained at the potential of initial reduction and potential of limiting current is noted and compared to a difference obtained on a known sample. In the instruments developed, this technique is performed by the instruments. Two voltages are applied alternately to the electrode assembly, one at the potential of initial reduction and one at the potential of limiting current. The difference in electrode current at these two potentials is measured, and the instrument calibrated in terms of current difference.

A polarograph was constructed to perform the above

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* This article is based on the following papers given at the Symposium on Instrumental Methods of Analysis held in Montreal by the Chemical Institute of Canada and the Instrument Society of America: "A continuous recording polarograph for use in metallurgical plants", W. K. GOWANS, Consolidated Mining and Smelting Co. of Canada; "Measurement of dissolved air in alkaline solutions from uranium mills and from gold mills", G. THOMAS and T. R. INGRAHAM, Mines Branch, Department of Mines and Technical Surveys, Government of Canada; "Oscillometric determination of uranium dioxide in solid samples", R. L. HARRIS and W.R. ROSSMASSLER, Union Carbide Nuclear Co.

operations and installed in the plant. A flow box was designed with sufficient baffles to reduce turbulence. A mercury column and reservoir with 20 inches head was used with the dropping mercury electrode. The calomel electrode was used with an extended salt bridge to prevent contamination. One and one quarter inches of capillary tubing rated at 2 to 5 seconds per drop was used for the dropping mercury electrode.

Accuracy of the initial instrument was checked by laboratory polarographs and found to be within 3 mg/l for a 45 mg/l full scale range. Due to low and constant level of ionised impurities below the half wave potential of cadmium, it was possible to run the instrument continuously at the potential of limiting current, with occasional checks to suppress the reading to zero at the current of initial reduction.

High cadmium concentrations encountered resulting in large electrode currents which could cause temporary changes in the calomel electrode. The problem was solved by using a time switch to "rest" the electrode $2\frac{1}{2}$ minutes in every 5, the recorder being also switched off. (Fig. 1.)

Two instruments have already been installed and put into continuous operation in the zinc leaching plants and results appear "very promising". As well, a third instrument has been designed for portable use, with an indicator for spot-checking. Daily maintenance includes removing salvaged mercury and cleaning of capillary tips. While at present used only for cadmium concentration measurement, they are provided with controls to measure concentration of other impurities if necessary.

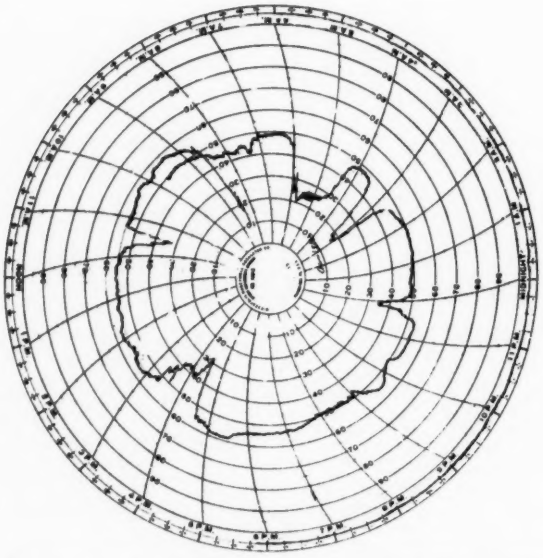


Fig. 1. Continuous polarograph recording of cadmium impurities in zinc electrolyte solution is shown. Full scale indicates a concentration of about 45 mg/l. At this level of concentration, recording is done $2\frac{1}{2}$ minutes out of 5 to "rest" the calomel electrode.

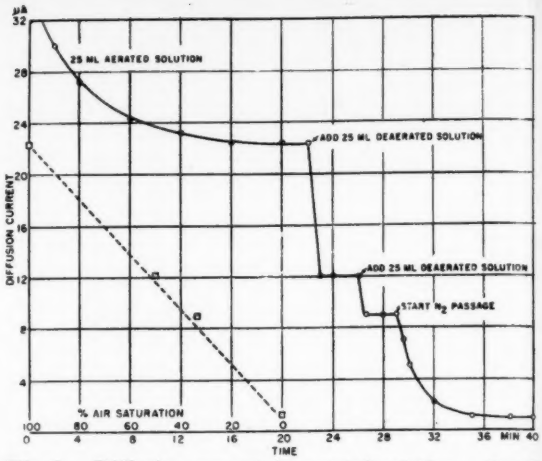


Fig. 2. Diffusion current in aerated solution. Graph shows calibration curve of diffusion current in Na_2CO_3-$NaHCO_3$ alkaline leach solution at 0·7 V potential. Steps are caused by additions of 25 ml of deaerated solution to original solution which is saturated with air. Final N_2 purge removes air from solution. Dotted line shows relationship between diffusion current and % air saturation for this apparatus.

Measuring Dissolved Air by Diffusion Currents

A simple and rapid method has been developed by the Extractive Metallurgy Division of the Department of Mines for determining relative saturation of air in alkaline solutions used in processing uranium and gold ores. Two typical equations for forming soluble complexes of these elements indicate the importance of dissolved oxygen:

$$UO_2 + \tfrac{1}{2}O_2 + CO_3^{--} + 2HCO_3^- \rightarrow [UO_2(CO_3)_4]^- + H_2O$$

$$2Au + \tfrac{1}{2}O_2 + 4CN^- + H_2O \rightarrow 2[Au(CN)_2]^- + 2(OH)^-$$

Lack of oxygen leads to poor efficiencies in the leaching circuits and lowered recoveries.

The following apparatus was devised by Extractive Metallurgy Bureau researchers for the measurement of diffusion currents. A No. 6 dry cell was used as a source of potential and the required fraction of its 1·5 V was selected from a 300 ohm rheostat. The current in the circuit was measured with a microammeter. To eliminate fluctuation in the readings, a 2,000 microfarad condenser was inserted in parallel with the microammeter. The potential applied across the electrodes was measured with a high resistance millivoltmeter. The use of a high resistance millivoltmeter in this application is essential if the microammeter readings of the diffusion current are to be accepted as correct.

In the preliminary experiments, it was found that the platinum cathode became polarised after use, making the measurements of diffusion currents erratic. To clean the electrode prior to making measurements, a secondary electrolytic circuit was introduced through which the cathode was made anodic for about 10 sec.

A sample of air-saturated mill solution was placed in the beaker containing the electrodes, and the potential between the electrodes was adjusted to 0·70 V and maintained there for about 20 minutes or until the diffusion current was constant. During this period, the electrodes became conditioned and were

ready for actual comparison measurement. In the first step of the comparison, the conditioning solution was replaced quickly by one of the standard mill solutions and the diffusion current was read immediately after the replacement. In the second step, this procedure was repeated with a fresh sample of aerated solution, to obtain its diffusion current, and after the reading had been made the solution was purged with nitrogen to remove the oxygen. The diffusion current of this purged solution was then read and its value subtracted from that obtained for the standard solution and that obtained for the air-saturated solution (Fig. 2). The ratio of these remainders, multiplied by 100, was considered to represent the percentage air saturation of the solution.

While this method remains basically a laboratory procedure, applicable to batch samples rather than continuous streams, it has shown that diffusion currents in actual uranium and gold mill solutions are proportional to percentage air saturation, and that a simple instrumental measurement can be used for process control. An extension of this development could well see this technique applied to a process stream instrument for continuous recording along the lines of Cominco's polarograph.

Oscillometry for UO_2 in Solid Samples

A recent U.S. development of interest to uranium processers is that of quick analysis of UO_2 content of powder mixture of uranium oxide with uranium tetrafluoride and uranyl fluoride. The wet chemical analysis of such a mixture offers considerable difficulty, when the following facts are considered.

Uranium is present in all three components of the mixture and in two different valence states. Fluorine is present in two of the three components. Oxygen is also present in two of the three components, and both oxygen and fluorine in one component.

Where the conventional analysis of a large number of samples of this type is involved, the process becomes necessarily laborious and time consuming. This problem is being studied by Union Carbide Nuclear Company for the United States A.E.C. A possible solution is offered by the application of high frequency techniques to direct measurements on the powder mixture.

Both uranyl fluoride and uranium tetrafluoride are non-conductors. The specific conductance of uranyl fluoride is not known but it is believed to be in the order of 10^{-12} (ohm-cm)$^{-1}$ which is the value reported for uranium tetrafluoride. The conductivity of uranium dioxide apparently varies with exact composition but falls in the range of 10^{-4} to 10^{-6}(ohm-cm^{-1}) and, therefore, it may be classed as a semiconductor. This procedure is then resolved into a conductance method carried out by high frequency techniques.

Samples are placed in a capacitor type cell which forms part of the resonant oscillating circuit. For conducting samples, a change in conductivity will result in a change in energy loss from the circuit since the sample acts as a power dissipating resistance in parallel with the capacitance (Fig. 3).

In order to reduce the sample size to a convenient value and still retain adequate sensitivity, a cell was constructed using concentric metal cylinders as electrodes. This design provided an annular space,

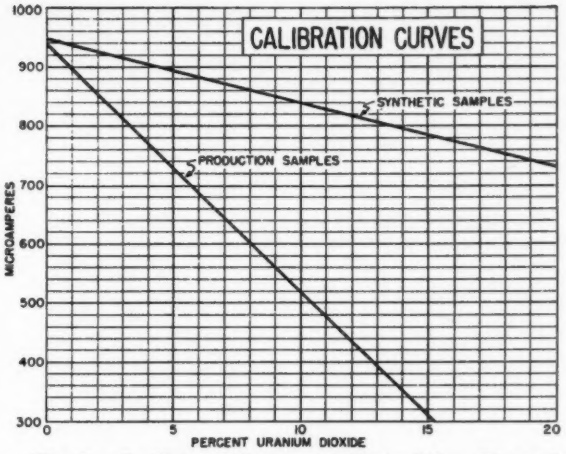


Fig. 3. Oscillator grid current indicates UO_2. Change in conductivity of powdered samples containing uranium oxide (a semiconductor) causes change in oscillator grid current. Difference between calibration curves of synthetic oxide-fluoride samples is caused by variations in composition of production oxide which varies with process used.

0·18 by 1·0 inches, to contain the sample. The cell will contain a 30 gramme powder sample and has a capacitance such that the oscillator operates at a nominal frequency of 17 megacycles.

Calibration curves, prepared by using synthetic samples made from measured mixtures of pure UF_4 and UO_2 were compared with working curves from large numbers of production samples. The difference between the calibration curves (see diagram) is explained by the fact that the conductivity of UO_2 varies greatly with its stoichiometric composition, which in turn varies depending upon its method of preparation from $UO_{2.00}$ to, say, $UO_{2.10}$.

According to the authors of the paper, "It may be said that the application of this method to powdered samples results in rapid reproducible indications of UO_2 content and requires approximately 2 minutes per determination. No sample preparation is required and the sample weight is not critical provided enough powder is used to cover the electrodes in the cell."

Infra-red Physics

Infra-red Physics is a new journal produced by Pergamon Press Ltd. as an international forum for the publication of scientific papers devoted to infra-red physics and its applications. It is concerned with infra-red theory, experiment, and instrumentation as applied to infra-red detection and transmission and to problems of atmospheric, meteorological, geophysical, astrophysical and space research. Except as they pertain directly to infra-red studies of planetary and stellar atmospheres, papers on molecular spectroscopy or spectrochemical analysis are considered outside the scope of *Infra-red Physics*. The journal will contain research papers, specially invited critical surveys, quickly published research notes and book reviews. The language preferred is English, but papers will be published occasionally in French and German.

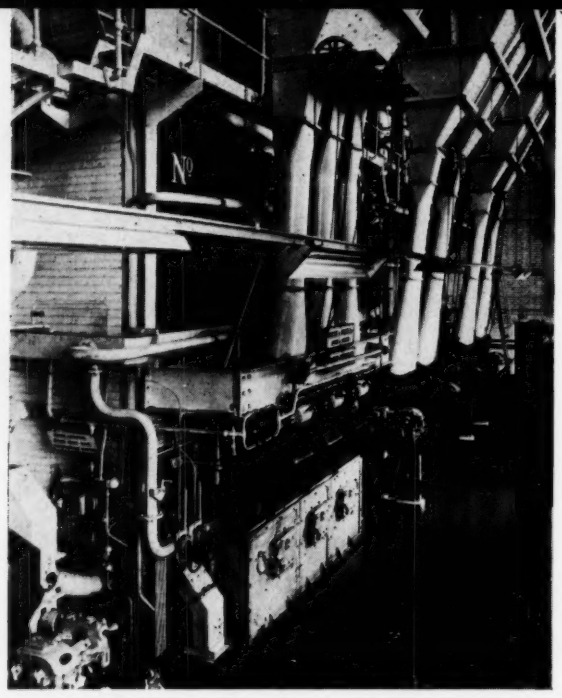


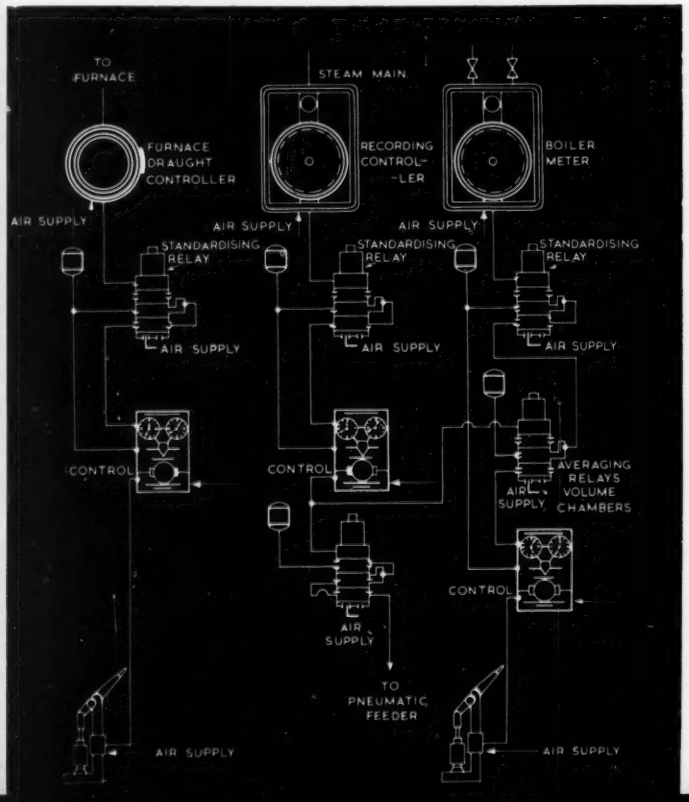
Fig. 1. Babcock-Detroit spreader stoker

By R. D. HOSKIN, A.M.I.Mech.E., A.M.I.E.E., A.M.Inst.,F.*

INSTRUMENTATION

Part I. The Automatic Control of Boiler Plant

Fig. 2. Layout of the control system



Introduction

OWING to increased production in the decade following the end of the last war, it was agreed to modernise the existing plant, and also provide for further expansion, by installing a new 30,000 lb/hour boiler. This unit would operate in conjunction with a back-pressure turbine, and would have stop valve conditions of 400 lb/in² and 700°F. The fuel specified for use with this new boiler was local coal, having a rank of 301, the characteristics of this coal being particularly difficult, from a combustion angle, in having a low ash fusion temperature, and a very high swelling index. After a considerable amount of discussion, it was agreed that the type of firing most likely to succeed with this fuel was spreader firing, and orders were placed with Babcock & Wilcox Ltd. early in 1957 for a watertube boiler having a Babcock-Detroit spreader stoker (Fig. 1). This unit has operated extremely satisfactorily since its introduction, and very high efficiencies have been obtained consistently. The main reason for the excellent performance has undoubtedly been due to the introduction of fully automatic combustion control, which is described in this article. It should be noted that a requirement of this method of firing is accurate control of combustion chamber

* Power Services Engineer, J. S. Fry & Sons Ltd.

This is the first of a series of articles describing process measurement and control instrumentation at the works of J. S. Fry & Sons Ltd.

...OCOLATE MANUFACTURE

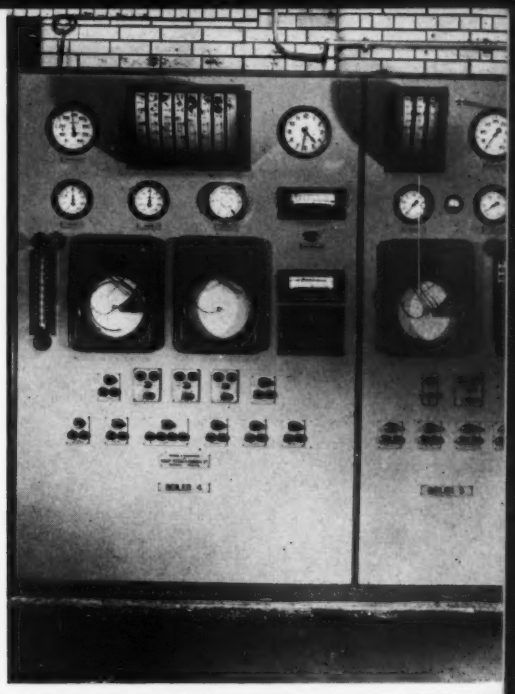


Fig. 3. Instrument panels for boilers 4 and 5

draught and under-grate draught, and since the fuel is partly burnt in suspension, this is very difficult to do manually. With the type of fuel being burnt at Somerdale, automatic control is virtually a necessity.

General Description of Instruments and Controls

The complete installation was supplied and installed by Messrs. Bailey Meters and Controls Ltd., and formed part of the modernisation programme mentioned in the preceding paragraph. The old boiler plant was included in the layout, although the main emphasis in this case was on instrumentation, only limited automatic controls being provided (Fig. 2).

Two centralised panels (Fig. 3) cover the operation of all the boilers, boilers Nos. 1, 2 and 3 being controlled from one panel, and No. 4, the new boiler, and No. 5 boiler from the other. It should be noted at this stage that all the old boiler plant is of the Babcock & Wilcox WIF type, and the boilers are fitted with chain grates, using coal from the Forest of Dean coalfield.

As the old boilers are smaller and much less complex than the new one, it was possible to arrange that the panels have the same external dimensions, thus forming a pleasing feature of the firing isle. Control of draught in the case of the old boilers, is limited to automatic control of combustion chamber pressure. Any manual adjustment of the forced draught (FD) fan causes a corresponding adjustment of the induced draught (ID) fan damper by the controls, and this is described more fully later. The new boiler has fully automatic control of fuel, air and combustion chamber pressure. Regulation of fluctuating demand is therefore easily achieved, since all the controls function simultaneously, and variations of steam load of up to 12,500 lb/hour in about ten minutes have been handled easily.

Although the controls function together it is necessary to describe them individually for clarity.

Master Pressure Control

A connection is made to the superheater steam outlet, and a signal is brought back to the master pressure controller, any deviation in this pressure signal results in a corresponding deviation in the air loading pressure. The alteration in the loading pressure actuates a standardising relay, and this, in turn, modifies the control pressure to the boiler selector valve. This unit comprises an air relay and set of transfer valves, providing automatic or manual distance control as required.

Fuel Control

The signal relayed from the boiler selector valve is fed through an accelerating and then a doubling relay to the spreader feeder mechanism, which controls the speed of the forward stroke of the feeder pistons.

Forced Draught

The control of forced draught is effected either by a signal from the boiler selector valve, or by the signal received from the steam flow/air flow ratio control, or a combination of both, the two signals being led to an averaging relay. Steam flow measurement is obtained from the differential pressure across an element inserted in the main steam line from the boiler to the steam main.

Airflow measurement is achieved by measuring the differential pressure across the boiler. In this particular case the tappings are taken from the combustion chamber draught measuring point and the economiser exit pressure point. The differentials produced by

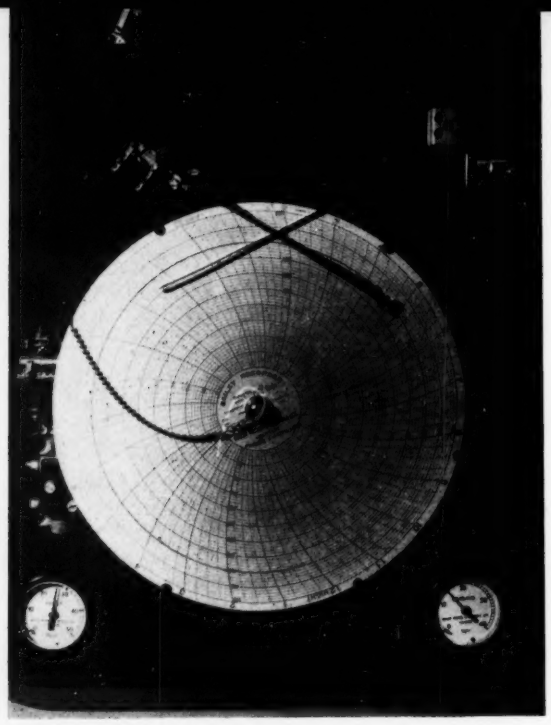


Fig. 4. Master controller recorder

this method act on the end of a ratio beam. Any alteration in steam flow, without a corresponding alteration in air flow, causes a variation in the signal to the standardising relay, thus modifying the control pressure to the averaging relay.

The control of FD is, therefore, affected by the master pressure control and also by the steam flow/air flow ratio control via the averaging relay and the FD control drive.

The steam flow/air flow ratio control is secondary however to the master pressure control, and any variation in boiler pressure will immediately alter the FD setting. Should this change cause a variation in the steam flow/air flow ratio, a signal will result in the correct ratio being restored (Fig. 4).

Induced Draught Control

Induced draught is controlled through variations in the combustion chamber pressure. The ID controller is of the diaphragm type, having combustion chamber pressure on one side, and atmospheric pressure on the other. Any variation in the required conditions results in a signal being sent to a standardising relay, which in turn alters the control pressure, via a selector valve, to the ID control drive.

The instruments are grouped to give maximum clarity, and all the standard readings of pressure, temperature and draught are provided. To avoid confusion, a CO_2 instrument was deliberately avoided, a regular check being made against the steam flow/air flow instruments with an Orsat apparatus so that under conditions of optimum efficiency, the two pens coincide. This method has proved to be very satisfactory since its inception, particularly in respect of lack of maintenance, and the operators have stated a preference for this type of instrument.

Smoke Density

A smoke density indicator was originally installed in the outlet from the new boiler. It was placed in this position because it was felt that any excess of smoke would automatically be attributed to the spreader stoker. It has been found, however, that the reverse is true in practice, and there is never any excessive smoke emission from the new boiler. Arrangements are in hand for the re-siting of the instrument in the base of the chimney, thus giving an indication for the whole boiler plant.

Acknowledgements

Acknowledgements are due to Messrs. Bailey Meters and Controls Ltd.

(Part II will be published in the August issue.)

NEW PATENTS

The following extracts have been taken from specifications obtained from the Patent Office, and permission to publish has been given by H.M. Stationery Office. The Official Journal *Patents* can be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2.

Patent No. 839,037. Temperature Change Detectors.

Graviner Manufacturing Co. Ltd. and Wilkinson Sword Co. Ltd. (*Inventor: Rupert Griffith.*) (*Application No.* 10858/56.)

The invention, relating to temperature change detectors and methods of manufacturing them, is particularly applicable for use in aircraft for indicating the existence of overheat conditions or fires. It may however also be used for industrial purposes. The general principle of the invention provides a detector of elongated form comprising inner and outer electrical conductors. The space between contains a refractory insulating material whose electrical resistance varies with the temperature. Thus a change in the temperature of the detector results in a change in the electrical resistance between the conductors. The refractory material may have a negative resistance versus temperature characteristic and it may appear that one material might serve both purposes, i.e. as the material whose resistance varies with the temperature; and as the refractory insulating material. In practice the maximum temperature which the refractory material must withstand without becoming soft is such that at normal operating temperatures the resistance of the refractory is too high for it to serve satisfactorily as the temperature sensitive material.

Patent No. 839,998. Electrical Computing Apparatus.

Metropolitan-Vickers Electrical Co. Ltd. (*Inventor: Anthony Hall.*) (*Application No.* 13229/57.)

Two quantities may be multiplied together by means of a potential dividing resistance chain in which one quantity is expressed as a voltage applied across the circuit and the other by the position of a slider along the resistance, the product being determined by the voltage appearing between the tapping point and the appropriate end of the resistor chain. It is not possible to obtain a sufficient degree of accuracy by the positioning of the slider along the resistance to represent the input quantity concerned. In the invention there is a computing circuit arrangement for multiplying the two quantities which comprises a chain of series connected resistances of graded ohmic values which are shunted by individual switches.

Patent No. 842,118. Analogue Computers.

The British Thomson-Houston Co. Ltd. (*Inventor: Michael John Millane.*) (*Application No.* 12940/57.)

This invention relates to analogue computers and in particular to those for predicting the minimum passing distance between two relatively moving objects which are approaching each other. This gives the invention an important application for use in conjunction with ship-borne radar equipment. It can be used for predicting the minimum passing distance between the ship carrying the radar and a second moving ship, from information obtained from the radar set of the bearing and range of the second ship at different times whilst approaching.

Patent No. 842,166. Instrument for Recording Telephone Messages.

Jacques Boudes (*France*). (*Application No.* 19282/57.)

The object of the invention is to provide apparatus whereby telephone messages may be received whilst the subscriber is absent. Such messages may be received in a relatively large number and permit use of a standard tape recorder. The instrument comprises an electrically driven tape recorder and announcer, an electric time switch and relays. The first relay causes connection to a telephone line and arranges completion of a current supply circuit to the recorder and time switch when an incoming ringing call is received. The second relay is operated after a short interval by the time switch to disconnect the telephone line from the first relay and to connect the line to audio input terminals of the tape recorder. The third relay serves, when unenergised, to complete a current supply circuit to the tape announcer and when energised to switch on the recorder.

Patent No. 843,159. Apparatus for Positioning a Movable Device.

The Foxboro Co. (*U.S.A.*) (*Application No.* 36614/58.)

The invention relates to hydraulic jet operator apparatus for positioning a movable device such as a valve or piston in accordance with an operating signal. Systems are already known in which the action is based on movement of a hydraulic jet from one receiving pipe or chamber to another in accordance with the operating signal. Due to such devices using a single, relatively small jet pipe which is moved from one to the other of a pair of small receiver pipes, reaction forces were encountered and the liquid volume applied in this manner was small, making it necessary to operate under relatively high pressure. Further, since the jet stream and the receiver pipes were round and the latter were spaced somewhat from each other, operation was on a relatively low sensitivity basis. In terms of modern instrumentation, a substantial movement had to be effected in this system to move a substantial portion of the jet stream from one receiver pipe to the other. In the invention a different arrangement has been introduced whereby one member has a peripheral arcuate jet slot and a second member has a jet receiving slot in the form of an arcuate opening arrangement and having an output connection therefrom. The two members are mounted for movement relative to each other whereby the jet slot is moved transversely into and out of operating alignment with the jet receiving slot—the two slots being of substantially the same length and co-extensive with one another. Means are provided for producing the relative movement in accordance with an operating signal and for supplying hydraulic fluid to the jet for ejection therefrom.

Patent No. 843,425. Radio-active Gauging Temperature Compensator System.

The Foxboro Co. (*U.S.A.*) (*Application No.* 28653/58.)

The invention relates to radio-active devices for gauging sheet materials with particular reference to such devices in combination with a temperature compensation system. Such devices commonly use a reference unit for balancing out temperature and barometric pressure effects on a measuring unit. Thus air density changes in a measuring unit gap are offset by like air density changes in a reference unit air gap. Further, a problem arises in that temperature changes are effective on the measuring unit more quickly than those on the reference unit due to barriers such as housing walls. This invention claims to overcome these difficulties by providing a system embodying additional, temporary temperature compensation during the delay period while temporary change is achieving full effectiveness on the reference unit.

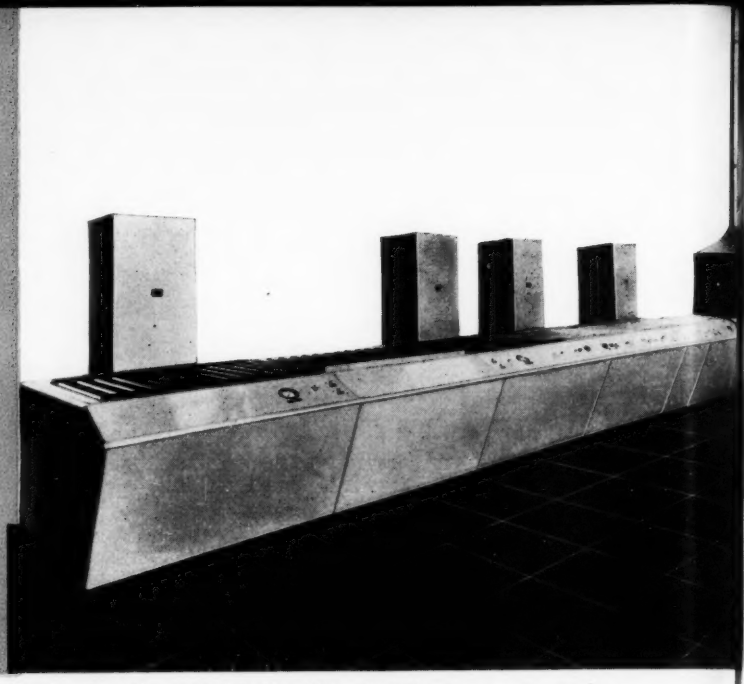
Patent No. 843,624. Measuring Thickness Instruments.

A. V. Roe & Co. Ltd. (*Inventors: Thomas Norton and Hubert Rainey.*) (*Application No.* 36297/55.)

The object of the invention is to provide an inexpensive instrument for measuring the thickness of non-metallic material such as wood, glass and synthetic resin products. The instrument comprises a combination of a transmitter and a receiver for placing on either side of non-magnetic material whose thickness is to be measured, and an indicator. The transmitter and the receiver each comprise a magnetic core on which is mounted a winding. The winding of the transmitter when energised by an alternating current causes the transmitter to generate external alternating magnetic field which, when the receiver is aligned therewith, induces in the receiver winding a signal dependent upon the spacing between the transmitter and the receiver and hence the thickness of the material. This signal is applied to the calibrated indicator.

Semi-Automatic Crack Detection Line

By N. F. LEE*



Semi-automatic crack detection line operating in an aero engine manufacturer's works

THE application of penetrants as a means of non-destructive testing, or more positively, flaw and crack detection, has become an essential process in the batch manufacture of components.

However, the equipment to handle this type of process is in many cases either antiquated, inadequate, or both, and the use of individual tanks linked with service pipes to other tanks at odd points adversely affects operators and slows through-put on the production line.

With this in mind, Revel Engineering Co. Ltd., of Hayes Road, Southall, have developed a modern streamlined appearance for this type of plant, with several unique features. Because of the diversity of products, the equipment is, of necessity, built to individual customers' requirements, and the illustration shows a typical installation operating in an aero engine manufacturer's works in Scotland. This unit is unusual in that it is designed for operation from both sides, all controls and instruments being duplicated. It will be observed from the illustration that all forms of overhead hoists are dispensed with, which considerably speeds up handling, but more important, enables the line to be used for several types of components at the same time and by several operators, thus increasing through-put and enabling this type of non-destructive crack detecting to be included in a production line.

Before describing in detail the process line, it is necessary to explain the Revel patented continuous track lift and agitation system, which forms the basis for the development. A platform fitted with roller track the size of the opening in the tank is raised and lowered into the solution by pneumatic cylinder. This is mounted on ball joints at the rear of the tank and clear of all solutions. The platform is supported by a framework which runs on rollers and guides in the tank and is connected to a support tube which in turn mates with a casting at the top of the unit. This casting carries further guide rollers working on a support column at the rear of the cylinder. This ensures that no strain is placed on the cylinder, and that there are no projections across the work area. The whole structure is of a robust nature and loads of up to 10 cwt at a time can be handled with safety. By the addition of two adjustable cams mounted at the rear of the machine and connected to the cylinder, the platform can be made to agitate in the solution at 4 to 90 strokes per minute. Two air circuits operating from one master valve ensure controlled ascent and descent into the solution and prevent splashing. The operating air pressure is from 60-100 lb/in², and experience shows that with clean air the life of the air equipment will outlast the tank life. Maintenance is virtually nil and it is only necessary to top up the oiler unit from time to time.

It is now possible to describe the sequence of operations on this plant and to simplify the description we will number each stage working from left to right.

The components to be tested are thoroughly degreased in a 3 stage Cresole, Para-wash and Trico degreaser (not shown), and then guided by hand on to the roller track platform of Stage 1.

Stage 1. Penetrant Tank

The pressing of the button to lower the work pieces into the solution also sets an electric timer, which on completion of the cycle rings a bell and shows a warning light. The operator then presses the lift button which raises the platform, switches off the bell and re-sets the timer.

Stage 2. Drain Area

This drainage is also time-controlled by push button to conserve the penetrant and permit the full capillary

*Director, Revel Engineering Co. Ltd.

action of the penetrant into any defects which may be present.

Stage 3. Penetrant Remover

After the prescribed period of drainage has elapsed, the work is immersed as described at Stage 1. Once again the timing principle is employed, after which there is a further drain period. This does not require timing and is usually kept to a minimum, which can be determined by the operator.

Stage 4. Hot Water Wash

After drainage the work pieces are immersed in hot water and agitated at 70 strokes per minute on a 4 - 5 inch stroke this being adjustable to suit the nature of the parts being washed. The water is heated to 60°C by an immersion steam coil and thermostatically controlled. The sequence is also time-controlled with the platform automatically coming to rest at completion of the operation. The use of agitation at this stage considerably speeds up the washing action and keeps this operation in line with the times for previous operations.

Stage 5. Hot Water Spray Rinse

The workpieces are transferred to this stage, the platform is partly lowered into the tank and hot water is pressure-sprayed using air/water spray guns. The water is heated by steam coil in a separate tank and the make-up tank concealed under the unit.

Stage 6. Hot Air Dry Off

This is an important part of the process line. It follows that after the workpieces have passed through both a hot wash and hot spray they will, if left to drain for a short period, allow moisture to evaporate by virtue of the heat retained in the workpiece itself. However, in the case of castings, or other work of an intricate nature, there are bound to be pockets where the water will not be able to escape. To combat this problem a hot-air dry period has been introduced. Experiments with the more conventional methods of ovens or tunnels proved to be a production hold-up, interfering with the overall operational efficiency of the line. It was further proved that access to all parts of the workpiece was necessary. The only practical solution to this problem was the supply of hot air from a flexible hose allowing the operator to direct this where required. To meet this heavy demand for hot air, it was necessary to incorporate into the equipment a cylinder approximately 6 ft long, using a steam coil to heat the air and supply this at 30 lb/in². This has proved exceptionally effective, and very cheap to operate, standard air nozzles being used for directing air.

Stage 7. Chalk Spray

This consists of a double side spray booth with roller tracking table, provision being made to collect surplus chalk via a hopper into a pull-out drawer unit. Exhaust ducting is fitted feeding to dust arrestor and then to atmosphere. Standard air-operated chalk spray guns are used for this function.

Stage 8. Inspection

After all the above processes the workpieces are now ready for the inspection department. Any defects such as laps, folds, porosity or cracks will be revealed to the inspector as colour indications, assuming either complete or partial linear definition.

It will be appreciated that the efficiency of any form of inspection system depends, to a marked extent, on the psychological effect of correctly designed plant and proper facilities being at hand. The joining of all tanks into one continuous unit, together with the placing of all controls at correct working height with steam, water and air service pipes concealed behind continuous flush panelling and valves accessible behind hinged doors, enhances the appearances of the shop. Maximum production is achieved as the operators are thus encouraged to take a pride in the process and relieved of the tedium of constant time checks.

The whole unit is 56 ft long × 5 ft $9\frac{7}{8}$ in. wide, the height to top of roller track is 3 ft $6\frac{9}{16}$ in. Each stage measures 5 ft 3 in. in plan. 2 in. hardwood capping is used around each tank to prevent accidental damage to any workpieces. All panelling is finished in stove enamelled paint of a colour to match chemicals being used, so that any inadvertent spillage of solution is not painfully obvious. The construction of the tanks is designed to suit the chemicals being used, and are manufactured from materials able to withstand the type of chemical in use.

Measurement of Load by Elastic Devices

The development of accurate elastic devices was first prompted by the need for a convenient means of verifying machines for testing materials in tension and compression. Other uses for elastic devices now include the measurement of forces applied to experimental structures and the thrust of jet engines and rockets. They are now also being very extensively used as weighing units in industry, ranging from portable units for weighing aircraft, to built-in units for weighing large storage hoppers and silos.

The latest addition to the NPL series *Notes on Applied Science**, published on 12th April, deals with the measurement of load by elastic devices. The Note defines the technical unit of force used when elastic devices are calibrated and outlines the facilities available at NPL for their calibration.

Descriptions and comments about their use are given for the more common types of elastic devices such as proving rings, standardising boxes, hydrostatic load capsules and electrical resistance strain gauge load cells. Guidance is also given on the accuracy of load measurement which can be expected from many of these.

Two final sections deal with temperature corrections and methods of plotting the calibration results graphically, thus permitting interpolation between calibration loads and the accurate transfer from one system of units of force to another.

*"Measurement of Load by Elastic Devices", NPL Notes on Applied Science No. 21. Published for DSIR by H.M.S.O. Price 3/- (by post 3/4d.) U.S.A. 54 cents.

R.E.C.M.F. SHOW

Bigger and better at Olympia

Introduction

THE Radio and Electronic Component Show for 1961 organised by the Radio and Electronic Component Manufacturers' Federation was of special significance. It was the first to be held at Olympia. The change of venue was necessitated by the growth of the industry. Mr. A. F. Bulgin, the President of the Federation, gave some significant figures in his opening speech. The turnover figure for the year 1960 was over £130 million. This was equivalent to the manufacture of 2,650 million different components. Still more important, as Mr. Bulgin pointed out, was the export situation. For 1960, the component exports were valued at more than £13½ million. This was 36½% above the 1959 figure. The exhibition was aimed particularly at the export market, and for the early part of 1961 the figures indicated that exports were of the order of 20% more than the preceding year.

In view of the President's remarks at the opening of the exhibition, the figures included in his message at the close were particularly interesting. The total number of visitors was 34,564. Of these 2,468 came from overseas, representing 56 countries.

Comparing this year's exhibition with the 1959 one (the last year in which it was held separately) it was five times as large, occupying a stand space of more than 72,000 sq ft in the Grand Hall. There were 250 exhibitors.

General Impressions

Whilst large numbers of electronic components are used by radio and television manufacturers, there is a wide field of applications in the computer, data logging, guided missile and general electronic instrument industries which is becoming more significant with each exhibition. The 1961 show at Olympia with its vastly increased space was beneficial in many respects, but particularly in that it permitted firms to show their ranges of products to greater advantage and allowed components for the newer applications to be displayed adequately.

There are several problems facing component manufacturers to-day but probably none is more acute than producing sub-miniature or even micro-miniature components without loss of reliability. This problem would appear to have been solved satisfactorily, for the number of components in these classifications has increased to a marked degree. This trend has enabled miniature pre-assembled units to be produced, and whilst those of interest to our readers are not numerous at the moment, it is felt that it would be beneficial to draw attention to some of those likely to be applied in the instrument industry.

Amplifiers

A specialist firm for many years, in the design of sub-miniature components, Ardente Acoustic Laboratories Ltd., showed a sub-miniature amplifier fully transistorised with a density of 300 components to the cubic inch. A typical design (Type 2167) involves a three stage amplifier which includes, in addition to three transistors, five capacitors, five resistors and one volume control. The gain at 1,000 c/s is 57 dB. The maximum output is ¼ mW with 0·5 mV input. The overall size is 0·53 in. × 0·25 in. × 0·33 in. The components forming such an amplifier must be equally sub-miniature in character and a typical resistor of 1/20 watt rating on the same stand measured only 1/5 in. long × 1/16 in. diameter. The components for the amplifier are wired and soldered under binocular microscopes, using specialised techniques.

Plessey pre-wiring loom

The Belclere Company were also showing sub-miniature amplifiers. Type B 4000, for example, has a rated output of 0·4 mW into 600 ohms. The input impedance is 4,000 ohms. Load current is 1·4 mA. On this company's stand was a significant example of what is claimed to be a micro-miniature component. This was the Type XN transformer measuring only 0·25 in. × 0·30 in. × 0·25 in.

D.C.-A.C. Choppers

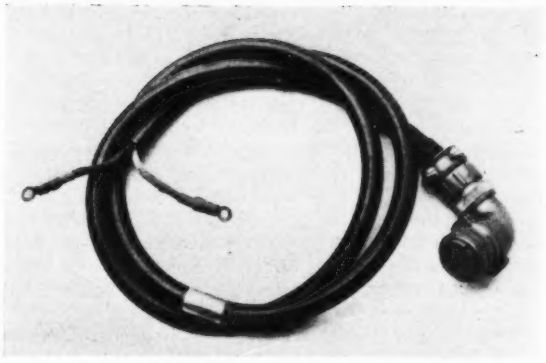
A unit of particular interest where it is necessary to produce a chopped signal from low level d.c. signals (as in thermocouple self-balancing instruments) was the SM10 chopper on the stand of the Telephone Manufacturing Co. Ltd. This is actually a design of Bailey Meters & Controls Ltd. It may be driven from any 6 volt sinusoidal or square wave supply with a frequency range of 40 c/s to 1,000 c/s. The d.c. input can range from 1 μV to 250 mV. It is fully encapsulated.

Filters

Filter circuits lend themselves to pre-assembled units. The Erg Industrial Corporation, for example, were showing a no-pass filter for 400 c/s. This involved three resistors and three capacitors. Each resistor is individually trimmed to ± 0·005% and is stabilised at this value. The overall dimensions of such a unit are $1\frac{5}{8} \times \frac{3}{4} \times \frac{3}{4}$ in.

Fans

Whilst not perhaps truly pre-assembled units yet miniature fans for cooling electronic equipment are felt to be of interest to readers. The Minicube version shown on the stand of A.K. Fans Ltd., measured only 1 × 1 × 1 in. It operates from a 400 c/s supply.



Amphenol cable assembly

Switches

The experience in one field can prove of benefit in another. There was a requirement for the improvement of certain switches on television receivers. This improvement was effected by plating contacts with gold, rhodium or palladium. The depth of plating necessary is only a few millionths of an inch so that the process can be made economical. It is felt that this development can prove useful in multi-point switching thermocouple installations.

Cable Forms

In an increasing number of equipments, particularly the more complex types, it is advantageous to make up complete wiring or cable assemblies on special boards away from the equipments. Such cables may be done by the manufacturer himself or may be sub-contracted. Several examples were on view at the exhibition.

AIRBORNE DIGITAL COMPUTING

THE role of the Royal Aircraft Establishment in the field of aviation is that of a laboratory providing a background of research and development knowledge to enable this country to produce equipment which will maintain its position in aeronautics and to contribute to defence projects in this and other fields. Many of the projects developed at the R.A.E. are taken up by industry.

The Open Days held recently at the Establishment at Farnborough provided an opportunity of appreciating the scope of the work undertaken at the Establishment. Specialised work is undertaken by the outstations of the R.A.E. At Bedford, wind tunnel experiments, flight research, blind landing development and naval air research are undertaken; Aberporth provides range facilities for testing missiles; pilotless target aircraft are based at Llanbedr; West Freugh is concerned with dropping trials on a coastal range; land range trials work is undertaken at Larkhill.

At Farnborough a team is responsible for the application of digital computing techniques to aircraft navigation. Airborne trials of DEXAN, an experimental digital navigation computer, have just been completed by a team comprising scientists from R.A.E. and G.E.C. (who developed the actual equipment).

Basically this new navigation system consists of a compass heading reference, a Dappler unit providing along track velocity and drift angle and DEXAN. The latter continuously resolves the data and computes the aircraft position, in terms of lattitude and longitude, 128 times a second.

DEXAN is a combination of the orthodox general purpose digital computer and a special purpose digital differential analyser.

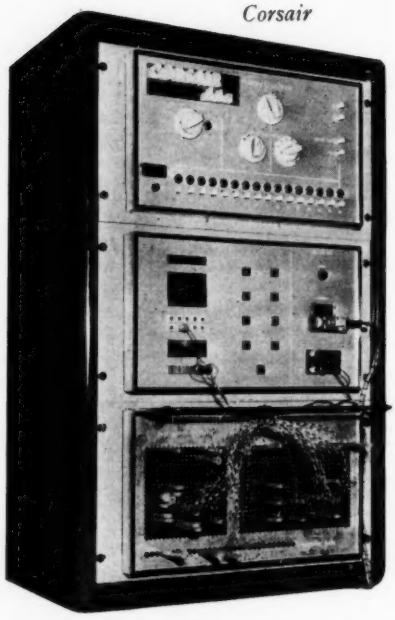
The latter is a new concept in digital computing having analogue features enabling it to fulfil the "continuous" aspect of DEXAN's role with the accuracy inherent in the digital principle. Because of the novel

nature of the d.d.a., programming experience is limited at the moment so to remedy this and to provide a computer which could be used as a reasearch tool generally in the new techniques R.A.E. designed and built CORSAIR, a fifty integrator digital differential analyser.

CORSAIR is small, compact and easily transportable and has been arranged so that programme techniques can be investigated with extreme simplicity on a patch panel principle. It has a maximum integration rate of 500 per second and a maximum accuracy of one part in 2^{15}. It is being made under licence by Messrs. Rank Cintel Ltd. for general sale as a small simulator and differential analyser.

DEXAN and CORSAIR are fully transistorised; a central core store is used in both rather than the drum or disc store popular in similar American equipment. CORSAIR has operated at the R.A.E. for nearly two thousand hours whilst DEXAN has completed some 35 sorties in a Comet and evidenced great operational accuracy. In some of the trials it was used to drive the Topographical Display Unit (also designed and developed at R.A.E.) where aircraft position is shown to the pilot on a continuously moving illuminated map display, in colour.

Corsair



The Culham Laboratory U.K.A.E.A.

Plasma Physics and Fusion Research

IN all countries, the main research aimed at power from the fusion of light elements (controlled thermonuclear reactions) is on the heating of an ionised gas, called a plasma, contained by magnetic fields interacting with currents in the gas. For this purpose, basic research on the complex physics of plasmas is essential, including the study of naturally-formed plasmas.

In October, 1959, the Atomic Energy Authority announced their intention to concentrate their plasma physics and fusion research at a new laboratory. In January, 1960, planning permission was given for the construction of this new laboratory at the former naval airfield at Culham in Oxfordshire. During the next three years the work already going on at Harwell and at the Weapons Research Establishment at Aldermaston will be moved to Culham. International collaboration in this field of research is widespread and free from restriction, so that Culham will be an " open " laboratory facilitating entry to visiting scientists, and the maximum interchange of ideas.

The work that Harwell have undertaken during the past decade on fusion and plasma physics has been largely concerned with methods of heating and confining plasma. The largest such device so far attempted is Zeta. Much of the recent work on Zeta has been aimed at discovering the sources of energy losses, and it has been found that these depend on operating conditions.

Containment studies have been extended to several systems quite distinct from the original pinch approach. They include hard-core containment in which the plasma is forced outwards rather than inwards, and cusp containment. The stabilities of these systems are being compared.

Alternative means of obtaining hot plasma are also being attempted. One method uses the development of shock waves in the plasma. Another method involves the injection of highly energised charged particles into a containment system from which they have little prospect of escape, e.g. a mirror machine.

The electrical engineering problems associated with these investigations include the production of high power pulses, the storage of electrical energy, and its switching and transmission. Much of the development work is carried out in collaboration with industry and it has in many instances acted as a stimulus in connection with standard products. This is particularly so in the case of capacitors and switches.

Use of Computers

Analogue Computer

The Electronics Division is studying a number of problems in the controlled thermonuclear reaction field and is using an analogue computer to assist in some of the investigations. These range from the analysis of non-linear electrical circuits to problems of particle dynamics and the behaviour of plasma in an electro-magnetic field.

The mathematical equations defining the motion of a charged particle in the mirror machine magnetic field are at present undergoing investigation on the computer. Two output voltages from the computer, one representing particle distance along the axis of the machine, the other radial distance from the axis, are displayed on a graph plotter. These voltages cause this instrument to draw out—on a much lengthened

time scale—a two-dimensional graph of the particle motion:

(a) when there is no corrugated region in the magnetic field, and
(b) when the corrugations are present.

This computer study is being used to provide a clearer understanding of the problem and to help optimise the field configuration for most efficient trapping.

Digital Computer

The mathematical problems involved in the detailed description of the behaviour of a plasma physics experiment are very complex and, in general, cannot be solved by normal analytical methods unless severe approximations and simplifications are made.

These problems can be solved more accurately by numerical methods and it is now possible, and economical, to include in a computer programme as many of the properties of the experimental device as are believed necessary to obtain a reasonable prediction of its behaviour. In general only a few of these properties can be measured directly in an experiment, but comparison with theory can often indicate which, if any, of these is the most important and suggest new measurements. If agreement is not forthcoming then both theory and experiment must be reconsidered in order to discover and eliminate the source of discrepancy. Once agreement has been obtained on the main feature it is then reasonable to infer, firstly that the basic theoretical concepts used are correct, and secondly that those properties remaining unmeasurable are correctly described by the calculation. At this stage the computer programme can be used to assist in the design of further experiments, probably of a type to investigate some phenomenon for which little or no theory exists. As the cost of large experiments rises and the cost of computing falls, this procedure becomes increasingly economical and desirable.

SIMA Notes

British Trade Fair, Moscow, 1961

All SIMA members have now returned from the British Trade Fair in Moscow and after an exhausting but rewarding three weeks have nothing but success to report.

It was gratifying to note that SIMA's last exhibition in 1960 was still in the minds of our Russian hosts and it was interesting to note how they regretted the absence of those members who were unable to attend this second venture.

The exhibition opened with the added goodwill of a personal attendance by Mr. Khrushchev. During the tour of the Fair by the official party, Mr. A. W. Jones, of Fleming Radio, President-Elect of SIMA, had the honour to be presented to Mr. Khrushchev.

Mr. Khrushchev spent some considerable time in Hall C and showed great interest in all the stands. In particular he was most interested in the Mullard stand where he remarked on the ultrasonic drilling equipment; he also spent some time on the Solartron stand where Mr. Blacklog explained the working of the X-ray spectrometers in which Mr. Khrushchev showed great interest. In addition, whilst on the Ultra Electronics Ltd. stand, he asked many questions about "SARAH" and its uses in air-sea rescue. His last stop in Hall C was at the E.M.I. stand and here he showed great interest in the colour television demonstration.

After the initial opening visits, exhibitors settled down to three weeks of unremitting toil, answering many questions and enquiries, including some from trade delegations from all the Soviet-Bloc territories and in addition one from the Chinese People's Republic.

Firm orders and contracts were not received until the end of the Fair and it was understood from the Russian authorities that this delay was in part due to the enormous number of enquiries that they had received, coupled with the fact that the availability of foreign exchange necessitated an allocation on a priority basis. However, final reports indicate that over 80% of the exhibits shown have been sold and that in addition most members exhibiting have received initial orders for further delivery ex U.K.

One of the greatest difficulties for exhibitors was to find time to have a meal or to take a moment's relaxation, some twenty minutes' walk to the restaurant, to be followed by a delay of nearly two hours, not being acceptable, and here the SIMA reception area proved to be invaluable. Members were able to draw breath and to use the running buffet which was staffed by two gallant ladies from the British Embassy, and this service above all others was appreciated by the exhibitors. In addition, Major F. D. Outridge, of the Secretariat, was present in Moscow and was able to save members a great deal of time by dealing direct with the administration in all matters requiring action by exhibitors and this again was most useful.

The SIMA Enquiry Service received a great deal of useful support and some 500 leaflets, together with Russian transcriptions, were delivered to potential buyers from all parts of the U.S.S.R. and, in addition, useful contacts were made with trade buying organisations from the other foreign delegations present, including one delegation from the Chinese People's Republic.

On the social side, members of SIMA attended receptions given by the U.S.S.R. Chamber of Commerce, by the State buying organisation, Mashpriborintorg, and, in addition, SIMA was also represented at the British Ambassador's reception. The President and executives of Mashpriborintorg have already accepted an invitation to a reception to be held by SIMA in London on the occasion of the Russian Trade Fair and it is expected that this renewal of acquaintance will bear further fruit.

In all, a most satisfactory and rewarding venture which in addition showed how much ground had been gained by the SIMA Exhibition in 1960 and also produced an exploratory invitation from the Russian authorities to stage a further SIMA Exhibition in 1962 or possibly 1963. (*Continued on page* 878)

Standards and Market Research

THE view was expressed by a speaker at this year's Standards Engineers' Conference that some British Standards were perhaps unnecessarily severe in the level of performance required of them. He instanced in particular such Standards as those for transformers, flame-proof enclosures and tower-cranes in which, he thought, the safety margin was often fixed at a point unrealistically high. Mr. I. Maclean (Hawker Siddeley Industries Ltd.), talking on "Standards and Market Research", made the novel suggestion that the British Standards Institution could perhaps give a lead in this field by setting up a market research advisory committee to see whether market research could not in some way be utilised in preparing Standards.

Market research could be important when standardisation was being considered.

Examining market research in relation to variety reduction, Mr. Maclean said: "If a potential customer is offered a choice between a standard product which does not exactly match his requirement and a special product at the same price, he will naturally choose the special. The reduction in costs arising from variety reduction must therefore be passed on to the customer if the company in question is not to lose all its customers whose requirements are not in line with the standard range of products.

"The extent to which the customer is willing to forego his exact requirements in favour of a lower price is obviously the sort of information that would be of great value in determining whether or not to introduce a range of standard products and also in determining the sizes within that range."

Mr. Maclean went on to explain the concept of the "life cycle" of a product: introduction, growth, maturity, saturation and decline. "In order to decide which products to standardise the place of each product in its life cycle should be known"—it was not enough merely to cut out products which made little or no contribution to turnover.

Expressing the view that some performance standards were set at an unnecessarily high level, Mr. Maclean instanced transformers, most of which, he said, were only required to operate intermittently for not more than 8 to 12 hours a day. But until recently, the standard for rating transformers was on a 24 hour basis.

The standard for flame-proof enclosures was much higher in Britain than on the Continent, he went on. The standard was often unnecessarily high in situations where the risk of explosion was almost negligible.

He alleged that the use of tower-cranes on building sites in Britain had been retarded because they were covered by a standard that was too high.

"The requirement was that a crane should be able to stand up to a wind force of 110 m.p.h. . . . the highest figure for a gust in the London area over a period of 33 years is 77 m.p.h. The original standard has now been revised but in the meantime costs have been incurred . . . costs that need not have been involved if the facts about the market had been fully known."

A sharp rejoinder came from Mr. J. I. Willmore (Manchester College of Technology). "We all know about dams that burst and cranes that get overloaded. Our standards are the highest in the world—let us keep them that way!"

From Mr. J. E. Dodd (Rolls-Royce Ltd.) came a complaint that, now a new type of nut had been introduced, no British firm could be found to supply the necessary spanners.

British Standards should be adjusted as necessary to come into line with those of other countries, said Mr. A. E. Fawcett (A. Reyrolle and Co. Ltd.). This was specially important, he believed, in view of our possible association with the Common Market countries.

In this connection, Mr. Maclean offered the interesting thought that the big markets of the future were not those of the under-developed countries but those of the already highly developed nations.

(*Continued from page* 877)

Health Physics Exhibition

SIMA, in conjunction with Dr. H. D. Evans, of the Imperial College of Science and Technology, have organised an exhibition of Health Physics instruments and equipment which is being held in the Concert Hall of the Students' Union, The Imperial College of Science & Technology, Prince Consort Road, on Wednesday, 12th July, 1961, in connection with a Summer School in Health Physics.

The Exhibition is designed to be of interest to all concerned with ionising radiations, their effects, measurement and control.

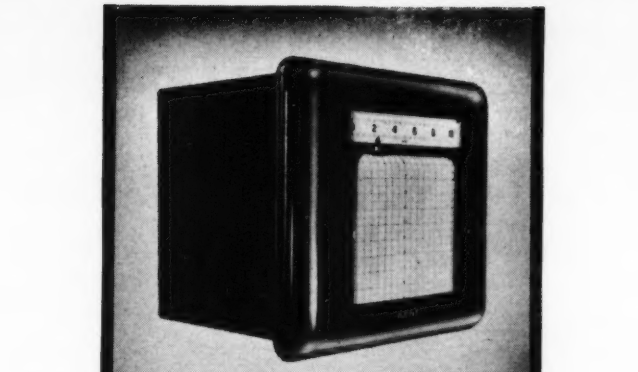
Eighteen firms are showing their products and much of the equipment will be demonstrated.

SIMA Exhibition in conjunction with the 5th International Congress of Biochemistry, Moscow, 10—16th August, 1961

SIMA yet again will be returning to Moscow to participate in an exhibition in conjunction with the 5th International Congress of Biochemistry which is being held in Moscow later this year.

Eleven member firms are taking part and arrangements are being co-ordinated by Mr. K. A. Macdonald, of Unicam Instruments Ltd., and Mr. J. C. Z. Martin, of Measuring & Scientific Equipment Ltd.

Circle 355 for further information



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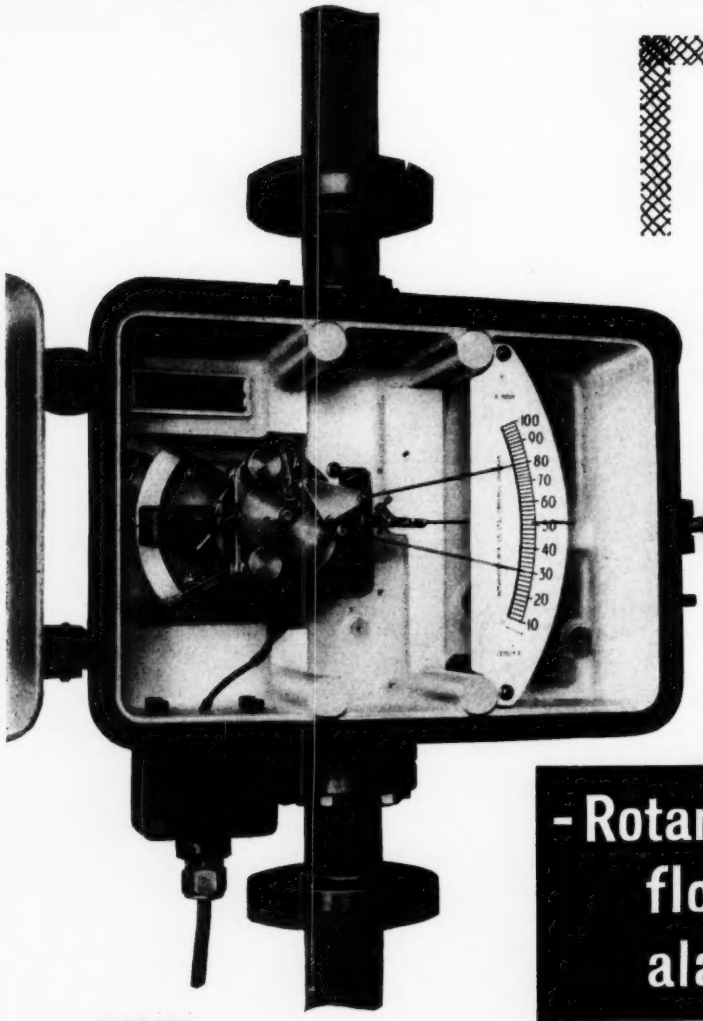

TYPE 500A

Electric or pneumatic signal, fully adjustable for liquids or gases.

METRIC SERIES

Adjustable alarm to fit on size 907 and 914 Rotameters. When float interrupts light beam, electronic relay is operated.

TYPE 825A

Alarm at low flow. For gas purposes intrinsically safe.

- Rotameter flow alarms

TYPE 750

Fixed alarm, non-indicating, electric signal, can be certified flameproof.

Where a change of liquid or gas flow rate is dangerous then one of these Rotameter flow alarms can be used to provoke attention. Electric or Pneumatic signals provide visual or audible alarm.

Type 500A has been specially designed to indicate high pressure gas flows in atomic reactor coolant circuits. It has two alarm points which are freely adjustable and which have a minimum differential of about 10% full scale. This instrument is also suitable for liquid flow.

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SURVEY OF NEW INSTRUMENTS

ELECTRICAL · ELECTRONIC · MECHANICAL · NUCLEONIC · PNEUMATIC

Temperature Controller

IMPORT-EXPORT & GENERAL SUPPLIES AGENCY has been appointed the sole agency by Hermann Koch of Stuttgart to distribute in Britain the temperature controller, Koch-Mikromat, as well as the other types of instruments: distant-reading thermometers, thermostats and car accessories.

MIKROMAT is a combination of a thermometer and a microswitch, or microswitches. It has a liquid filled capillary tube and the maximum length of it can be 65½ ft. For special application the capillary can be extended up to 300 ft by incorporating one or two, or several compensators. −60° + 350°C is the normal range of this type of the instrument and it can be obtained in the following sizes of the dial: 60 mm, 80 mm, 90 mm, 100 mm, and 160 mm. Accuracy of the instrument is 1% of the scale and the differential between ON and OFF is maximum 2% of the scale.

The diameter of the capillary does not exceed 2 mm. Length of the capillary does not influence size of the feeler rod, and therefore manufacturers of plastic machinery should find the instrument useful as a temperature controller for the plants.

There are several types of MIKROMAT with the circuit breaking capacity of 3·5 A and 5 A, 250 V, and 10 A, 15 A −460 V a.c.:

(a) with one variable contact;
(b) with two variable contacts (for maximum and minimum);
(c) with one variable contact and one pre-set point;
(d) with 1, 2, 3, or 4 pre-set points for push-button controls.

Most of the above mentioned types of MIKROMATS can be fitted with a control or safety switch at a critical temperature. Only 90 mm dial MIKROMAT is made in square panel-mounting case. In most cases the cost of the above instruments does not exceed cost of an ordinary vapour-pressure thermometer and prices vary from £6 10s. 0d. to £14 10s. 0d., depending on type and specifications.

Circle **1** *for further details.*

Accelerometer

TECHNICAL CERAMICS LTD. has introduced a new accelerometer, Type G 170, for vibration tests in a wide range of applications. Particular uses of this accelerometer are in the aircraft and automotive industries and in the development of shockproof packaging techniques.

A special feature is its light weight of 5 g which enables it to be used for testing component parts as well as complete assemblies. It is ½ in. long and ½ in. diameter, and is fitted with a sub-miniature coaxial connector. The G 170 will operate over a frequency range from 5 c/s to 3·5 kc/s, and will measure shock and vibration in the range 0·1 to 400 *g*. Operating temperature is −40 to +80°C and the units are fully sealed to withstand conditions of high humidity.

The accelerometer uses a bender-type transducer to give maximum sensitivity in a coaxial direction with minimum sensitivity in other directions. A high self-capacitance has been achieved, which enables measurement to be made at low frequencies using a cathode follower unit.

Circle **2** *for further details.*

Pressure Transducer

COUTANT announce the first in their range of pressure transducers, designed primarily for industrial application. The Model CP.12 is a miniaturised version.

Although firstly manufactured for the hydraulic engineer, it has since been proved in the aircraft and other industries requiring a small reliable and robust transducer. Among many of its features are:

(1) the large electrical output which is suitable for display directly onto a meter, oscilloscope or valve voltmeter
(2) low hysteresis which under many applications is not measurable.

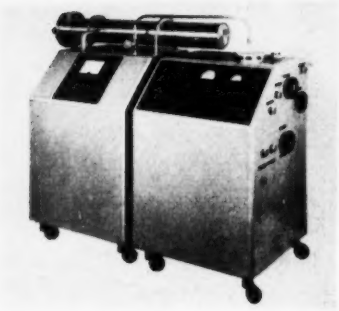
Pressure range:	0-8,000 lb/in²
Output:	1 volt at 5,000 lb/in²
Operating Temperature:	85 or 105°C
Terminal Linearity:	1·5%
Hysteresis:	better than 0·25% Dynamic 1·5% Static
Size:	¾ in. diameter × 1½ in. long including connector
Price:	£20. Delivery: Four weeks.

Circle **3** *for further details.*

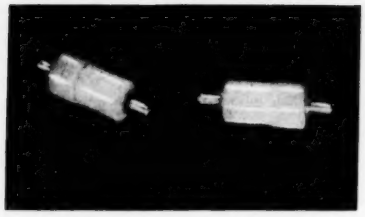
Selector Switch

THE Class 9001 Type TS selector switch is an oil-tight switch equipped with an operator, the physical dimensions of which allow easy operation by operators wearing gloves. It is available from Square D Ltd.

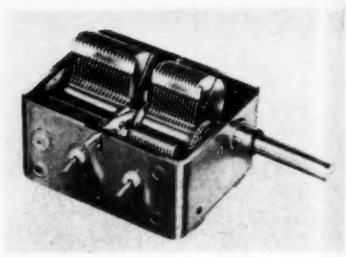
Circle **4** *for further details.*



◀ *Fuel element tester*



Wiring and component mounts



Two gang capacitor

Fuel Element Tester

AN instrument for testing fuel elements for nuclear reactors has just been produced by 20th Century Electronics Ltd.

The unit consists of a mass spectrometer leak detector together with an auxiliary pumping unit which is connected to an enclosure for testing single fuel elements. The technique employed is as follows:

The fuel element is internally filled with helium at reduced pressure. In carrying out the leak tests the fuel element is loaded into the enclosure and the enclosure is evacuated to a pressure of 10^{-5} mm of mercury using the auxiliary pumping system. The enclosure is isolated from the pumping system for a period and is then connected to the mass spectrometer leak detector tuned to the helium peak to measure the pressure rise over a period of time.

A calibrated leak is supplied for setting up the instrument sensitivity and the complete operation of testing a fuel element takes only ten minutes. The instrument shown in the photograph is for the testing of individual fuel elements, but the pumping system is capable of sampling volumes up to 300 litres, and the unit can be attached to manifolds of testing enclosures for batch production.

The complete instrument is ideal for either laboratory requirements or for batch testing systems, and the first production model has recently been exported to Japan.

Circle **5** *for further details.*

Wiring and Component Mounts

A NEW range of Sealectro " Press-fit " one-piece p.t.f.e. insulated stand-offs, terminals, feed-throughs, and turret-type anchor points is available from Sealectro. The range is designed for use in chassis of approximately 0·048 in. thick and provides greater rigidity for assembly convenience and increased equipment reliability.

The new range of " Press-fit " terminals requires a slightly larger mounting hole for the p.t.f.e. body. The metal stud running through the body is of heavier design than normally used. The resulting installation provides far greater mechanical stability for both wiring and component mounting.

Circle **6** *for further details.*

Ganged Capacitor

THE PLESSEY CO. LTD. is now marketing a new two gang capacitor, Type **28**, intended for those radio receivers demanding a high performance tuning unit.

The rigid style of frame ensures freedom from low-frequency microphony and the rigid rotor assembly and widely-spaced vanes in the oscillator section give freedom from vane microphony. The capacitance swings are ample for all wave ranges and are very suitable for the full shortwave band without padding correction. A high order of capacitance matching accuracy between the two sections enables the receiver designer to provide tuned circuits with a negligible loss due to any mis-matching between r.f. and oscillator sections.

An internal gear drive can be fitted, standard ratios being **3** to **1**, **6** to **1** and **8** to **1**.

Circle **7** *for further details.*

Continuous Digestor Unit

AN instrumental system of continuous automatic chemical analysis, known as a continuous digestor unit, which permits automatic analysis of nitrogenous compounds with a degree of reliability and reproducibility unobtainable by conventional methods, is now available for use with the Technicon AutoAnalyzer.

The classic Kjeldahl procedure consists of the introduction of a sample into a suitable flask with an appropriate digestive solution, prolonged boiling of the organic matter to oxidise the carbon and hydrogen with reduction of the sulphuric acid to sulphur dioxide, and subsequent reduction of the nitrogenous matter to ammonia. The procedure requires considerable manipulative operations in order to arrive at a quantitative answer. In addition, large laboratory space is required for the equipment involved.

The new Technicon system, applicable to both reductive and oxidative types of digestion, completely eliminates the traditional stumbling block to automating Kjeldahls and similar digestion-requiring procedures. No longer is it necessary to provide for a suitable time lag to enable such phases of the process as reduction and oxidation to occur. Additionally, it eliminates the need for isolating each phase in the digestive procedure from the previous phase and from newly-introduced sample material just beginning the digestive process. Equally important is the fact that it handles the work with equipment occupying but a fraction of the space required for conventional methods.

Integrated with the Technicon AutoAnalyzer, the new unit provides permanent recorded results on a graphed readout. The multiple proportioning pumps in the AutoAnalyzer are used to continuously supply

digestion mixtures to the digestor, to present the sample continuously or intermittently and, in the final stages, to remove an aliquot of the digested product for final mensuration and recording.

The digestor vessel is a glass Pyrex tube with helical indentations. It has an overall length of 31 inches and a diameter of 2 inches. By rotation of the tube, liquid introduced at one extremity is conveyed in individual puddles or segments to the other extremity. Both extremities of the tube are slightly tapered to prevent condensed moisture from dropping off the end of the tube.

The entire unit is fitted within a hemispherical type furnace where variable-speed rotation is achieved through wheels driven by a variable geared motor. The method permits adjustment of the speed of rotation and thus of the duration of the digestion phase. The faster the tube is rotated, the shorter the time allotted to the digestion of the specimen. An electronic-type temperature control and indicator permits heat adjustment from room temperature to approximately 700°C, an important additional factor in providing a control method for the length of the digestion period.

On emergence from the digestion vessel, the excess fluid is removed and sent to waste, fumes and water vapour are aspirated and exhausted, and the highly concentrated digestion is diluted, cooled and aspirated.

In the final step, the fully digested and prepared material is introduced into the AutoAnalyzer for analysis and permanent recording of the results on a graphed readout. The entire process is automatic with no human manipulation required.

Circle **8** *for further details.*

Spring Material

JOHNSON MATTHEY & CO. LTD. announce the development of Mallory 53, a nickel-silicon-copper alloy that fulfils the need for a spring material with mechanical properties at least equal to those of the conventional phosphor bronzes and brasses, but with appreciably higher electrical conductivity.

Because of the exceptionally high electrical conductivity of the alloy, 40-45% I.A.C.S., it is possible for springs of small section to carry appreciably larger currents when made in Mallory 53 alloy than when made in phosphor bronze. Advantage can be taken of this characteristic to increase the current rating of existing designs of springs.

All spring forming operations can be applied to Mallory 53 after heat treatment and hence the alloy is supplied in the precipitation hardened condition requiring no further heat treatment by the user.

Circle **9** *for further details.*

Display Oscilloscope

A NEW oscilloscope introduced by Airmec is designed for use primarily as an instructional and demonstration instrument for displaying low frequency (0 to 10 kc/s) waveforms. A 17-inch cathode ray tube is fitted, having a brilliant orange trace with a long afterglow effective up to approximately 30 seconds in normal room lighting. The full area of the screen is usable and the display is clearly visible from the greatest distances normally encountered in classrooms.

The instrument consists basically of the c.r.t. and its controls, together with X and Y amplifiers having input terminals on the front panel. Two additional units, a timebase generator and a beam switch unit, are built in and feed the X and Y amplifiers through quick-release links between the front panel terminals.

The timebase generator provides sweep speeds continuously variable from one second to one millisecond and is synchronised internally from the Y1 input channel in the beam switch unit.

The beam switch unit incorporates four Y preamplifiers, each with its own gain and shift controls and a coaxial input terminal on the front panel. It may be set to give a 1, 2, or 4-trace display, enabling up to four related waveforms to be shown on the screen at once.

The instrument is normally used with its own timebase generator in operation, but this may be quickly disconnected by removing the front panel links. External signals may then be applied directly to the X amplifier for generating Lissajous figures, and if required four such figures may be displayed at once by using the beam switch unit.

Circle **10** *for further details.*

Stabilised Power Supply

A NEW 30 V, 3 A, fully transistorised power supply unit has been developed by Rotax Ltd. One of its features is a filter circuit which enables the number of transistors used to be kept to a minimum, resulting in greater simplicity and overall reliability. The stabilised voltage output is variable from zero to maximum, overall stability factor 1: 1,200, and d.c. resistance less than 0·01 ohm. Adjustable overload protection is provided.

Circle **11** *for further details.*

Limit Switches

SQUARE D LTD. announce important additions to their Class 9007 Type AW oil type limit switch range.

The first is an adjustable length roller arm, adjustable in length from 1 in. to 4 in. The use of this arm will eliminate wasteful setting up modifications and conserve design labour.

The second addition is a roller arm infinitely adjustable through 360°. The arm can be adjusted to any angular position by rotating the knurled adjusting micrometer dial on the spindle of the arm. A graduated scale on the spindle is clearly marked in 20° graduations for easy setting of the arm position. One complete turn of the micrometer dial will move the arm through 20° from one graduation mark to the next A reference mark is located on the moving portion of the arm and the micrometer dial is provided with a position indicator. In consequence accurate presetting and subsequent adjustment of the arm to any angular position is easily accomplished. Arms are available with a $\frac{5}{8}$ in. diameter × $\frac{1}{4}$ in. wide roller and in various lengths from $\frac{5}{8}$ in. to 3 in. long.

Rollers on both types of arms can be changed from outside to inside positions without the use of additional parts.

Circle **12** *for further details.*

Anti-corrosion and Anti-moisture Treatment

HELLERMANN CRC 2·26 is a simple but effective anti-corrosion and anti-moisture treatment for electrical and electronic equipment.

It can penetrate pores, cracks or holes displacing absorbed moisture. After driving the moisture out, CRC 2·26 forms a film to prevent further contamination. This film does not become brittle or crack and is an excellent corrosion inhibitor for metallic surfaces. CRC 2·26 also has a beneficial lubricating effect on moving parts.

Hellermann CRC 2·26 is supplied in a 16 oz aerosol dispenser and can readily be used on the production line and takes up very little room in a tool kit. It is also available in 1 and 5 gallon cans and 55 gallon drums for brushing and immersion.

Circle **13** *for further details.*

Gas Thyratron

THE 2050-A gas-filled thyratron is of the tetrode type and has been specially designed by R.C.A. for use as a relay tube in welding-controlled units and in power supplies.

Design features are:

steep control characteristic (high control ratio) essentially independent of ambient temperature over a wide range

relatively high leak-cathode-current rating and low heater-power requirements

low preconduction or gas-leakage currents right up to the beginning of conduction.

Circle **14** *for further details.*

Mesa Transistors

RCA have available 3 high-speed germanium p-n-p mesa transistors, the 2N705, 2N720, 2N711. They are designed for critical applications in military and commercial data-processing equipment where exceptional stability of characteristics for reliable performance is a primary consideration.

These diffused-base mesa transistors are designed to meet the rigorous testing requirements of MIL-S-19500B and feature:

high power-dissipation capability — 150 mW max. at 25°C

high minimum beta (h_{FE}) of 25

typical alpha-cutoff frequency — 300 Mc/s

fast switching

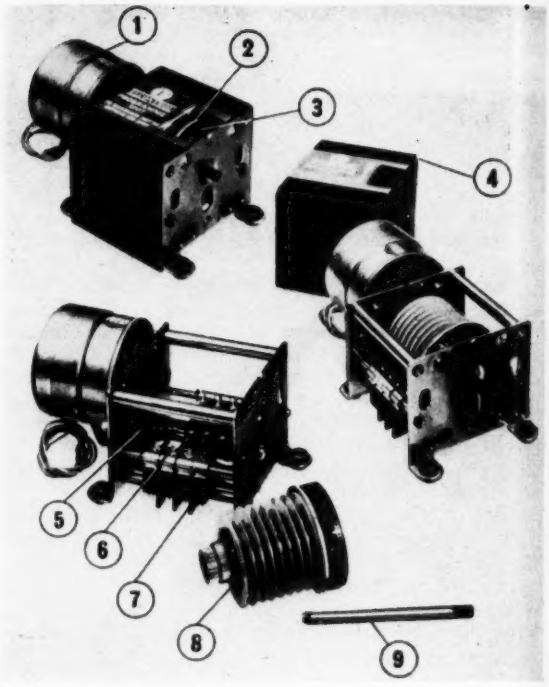
JEDEC TO-18 package.

Circle **15** *for further details.*

Miniature Programming Unit

THE programme timer Type MA2 is the first of a new series of precision cam timers to be produced by Elcontrol, using snap action microswitches to provide control contacts for an automatic sequence. Further models with additional facilities are being developed.

The unit is constructed around a central cam shaft consisting of eight independent cams, each of which is operating an individual change-over microswitch, via a specially designed rapid action cam follower. A synchronous motor drives the cam shaft at the speed required to provide the necessary cycle time for any given control sequence.



Motor programming unit:

1. *Self-contained motor and gear unit*
2. *Hand reset knurled disc*
3. *Visible dial*
4. *Dust cover*
5. *Gear clutch*
6. *Independent switch adjustment*
7. *Snap action enclosed microswitches*
8. *Removable camshaft*
9. *Layshaft bearing*

The timer has been designed to meet the growing demand for a more versatile cam switch particularly suited to modern product design and production techniques.

The complete eight stage timer, with eight change-over 250 V 5 amp switches, measures $4\frac{3}{8} \times 2\frac{5}{8} \times 3$ in. including motor and dust cover.

Each switch, being of the enclosed snap action type, may be individually adjusted by set screw allowing the trip point to be set with high accuracy for critical control. The shortest pulse length is 5° but by adjustment this may be reduced to as little as 2°.

A large range of instant start synchronous motors is available giving periods of operation from 60 rev/min to 1 rev/min for twenty-four hours. Motors are of very robust construction and incorporate felt lubrication reservoirs requiring no attention.

Extended cam switches can be produced to order, up to thirty-two individual switches being operated from one cam shaft.

The price of the standard 230 volt 50 cycle, eight cam unit complete is £12 10s. 0d. each.

Circle **16** *for further details.*

Universal Bridge

THE accuracy of Wayne Kerr's universal bridge B221 has now been increased from ± 0·25% to ± 0·1% over all ranges and the accuracy of comparative measurements is ±0·02%.

The price of the B221 is unchanged.

With low impedance adaptor Q221, the bridge measures inductance from 0·005 μH to 1,000 H, capacitance from 0·0002 pF to 5 F and resistance from 50 μΩ to 50,000 MΩ.

Another recent addition to the B221 is the provision of connectors for an external source and detector which enables the bridge to be operated at any frequency between 50 c/s—20 kc/s.

Circle **17** *for further details.*

5-Circuit Carrier Telephone Terminal Equipment

TMC R4A equipment is a compact self-contained audio plus four circuit carrier telephone terminal for use with junction radio links. The overall frequency band is from 0·3 to 28·3 kc/s and audio circuit bandwidths are from 300 to 3,400 c/s. Out-of-band frequency-shift signalling, compatible with various methods of local signalling, is provided. The equipment may be supplied as loose panels, as a set of wired panels linked together or self-contained in a portable cabinet. It employs plug-in units and this permits considerable flexibility, enabling terminals to be sub-equipped for any number of simplex or duplex channels, with or without provision for signalling. The construction of the R4A provides easy access to individual units and reduces maintenance time to a minimum.

Energisation may be from either a.c. mains or battery supplies and transistor circuitry ensures low power consumption.

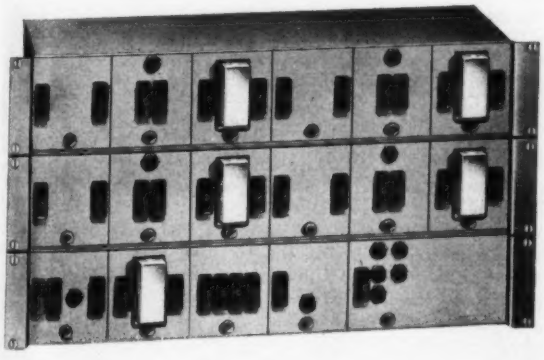
The overall channel frequency response is such that with two systems (four terminals) connected in tandem through distortionless networks the frequency/attenuation response is within the CCITT recommended limits.

Points in the transmission circuits are accessible through U-links for testing and monitoring purposes. A monitor telephone set occupying $1\frac{3}{4}$ in. of rackside height can be provided as an optional extra. This set provides listen and speak facilities on the 2-wire audio circuits and on service lines. A transmission test set and a signalling test set in portable or rack mounting form can be provided as optional extras.

Together the three panel shelves measure 20 × $10\frac{1}{2}$ × $8\frac{1}{4}$ in. (50·75 × 26·7 × 21 cm) and weigh 65 lb (2·92 kg).

Channel bandwidth	...	300 to 3 400 c/s
Overall bandwidth	...	0·3 to 28·3 kc/s
Impedance:		
to radio	...	600 ohms (unbalance)
to audio	...	600 ohms (balanced)
Levels:		
Audio 4 W input	...	−14 to 0 dBm
Audio 4 W output	...	−4 to + 3 dBm
to radio transmitter	...	−37 dBm
from radio receiver	...	−8 dBm
Signalling frequency	...	4,300 c/s quiescent condition
Signalling deviation	...	−180 c/s
Carrier frequencies	...	12 and 24 kc/s
Frequency stability	...	better than ± 2 c/s with ± 10% supply voltage
Noise (referred to point of zero relative level)	...	less than 1·5 mV emf weighted
Ambient temperature range	...	5 to 45° C
Power consumption	...	10 VA approx.

Circle **18** *for further details.*



5-circuit carrier telephone terminal equipment

Metal Film Potentiometer

A NEW type of small electronic component developed by Short Brothers & Harland Ltd. for use in the guidance system of the Seacat guided missile incorporates a metal film deposition process which is to be used under licence by Miniature Electronic Components Ltd., of Woking.

This component, a metal film potentiometer forming part of a cordite-driven displacement gyroscope, gives better performance than conventional instruments of its type.

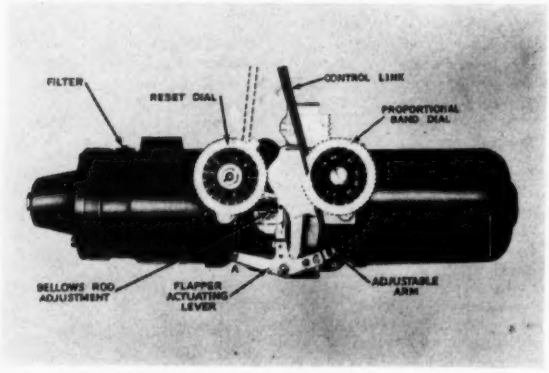
The conventional type of potentiometer was found unsuitable for the high degree of miniaturisation required in the Seacat missile. There are limits to the fineness of a resistance wire. Another disadvantage is that since the resistance wire is usually coiled, the wiper passing along it must proceed in a series of jumps; thus the wire can be tapped only at a series of given points.

To overcome these problems, Shorts Precision Engineering Division developed a potentiometer in which the resistance wire is replaced by a very fine film of metal. This film is less than one millionth of an inch in thickness and is deposited on a special high temperature ceramic by high vacuum technique.

The ceramic to be coated is positioned at the top of the vacuum chamber and is suitably masked to cover areas on which no film is required. A small piece of metal—usually nickel chromium—is placed on a heating coil and vaporised at a temperature of about 2,500°C. The cloud of metallic vapour rises and condenses on the exposed areas of ceramic in the form of a thin, perfectly smooth film.

The film gives great resistance to the passage of electricity because of its extreme thinness and thus permits the manufacture of very small potentiometers. The metal film potentiometer also possesses " infinite resolution ", since the wiper touches all points along the length of the resistance in a perfectly smooth progression. In missile servo mechanisms, where the full travel of the wiper may be only a small fraction of an inch, infinite resolution is of great value.

Circle **19** *for further details.*



Batch Air-O-Line unit

Pneumatic Control System for Batch Processes

A TWO-TERM pneumatic process control unit for use on batch processes has been developed by Honeywell Controls Ltd.

Designed to counteract " overshoot " on start-up, it is known as the Batch Air-O-Line and is suitable for use with electronic strip chart recorders and pressure gauges.

With existing proportional-plus-reset pneumatic control devices, when the recording pen is outside the proportional band, accumulation of air in the system during the shut-down procedure will cause overshoot on start-up. This gives rise to delays in processing and endangers quality. The Batch Air-O-Line will reduce or prevent overshoot by automatically discharging accumulated air when the pen moves out of the proportional band.

When the process is shut down, the controller output increases. When it reaches 15 lb/in² a bleed valve opens to exhaust the accumulated air and the proportional band is simultaneously shifted downscale by blocking off the reset chamber. The controller output thus stays saturated during shut-down.

On restart of the process, the reset chamber exhaust is shut and air returns to the reset chamber, reducing the controller output. The proportional band gradually shifts upwards and set point is reached without the usual cycling.

It is emphasised that the new technique does not slow the response of the process; the approach to the set point is simply made more gradual on start-up. Normal process control remains unaffected subsequently.

Circle **20** *for further details.*

Germanium Alloy-diffused Mesa Transistors

TEXAS INSTRUMENTS has today extended its range of transistors with three new germanium alloy-diffused mesa transistors, specially designed for operation in high frequency amplifiers and fast switching circuits.

Each device type is characterised to facilitate circuit design covering the following applications:

2G401—high gain i.f. amplifier at 465 kc/s and 10 Mc/s

2G402—v.h.f. amplifier at 100 Mc/s

2G403—logic and arithmetic circuits operating at clock rates of 10 Mc/s.

To ensure high reliability under extreme environmental conditions these transistors are hermetically enclosed in an all-welded JEDEC TO-5 package. Wide lead spacing permits automatic insertion on printed boards in production equipment.

The alloy-diffused mesa technique optimises the performance achieved in currently available devices ensuring low leakage currents, improved high frequency operation, good bottoming characteristics and increased power dissipation. These features combined in a single device are particularly advantageous in reducing circuit complexity and in relieving the designer of the need for unnecessary adaptation of circuit to achieve optimum performance.

Absolute Maximum Ratings ($T_{amb}=25°C$)		Types 2G401 and 2G402	Type 2G403
V_{CB}	Collector-base voltage (common-base circuit)	20 V	—40 V
V_{CE}	Collector-emitter voltage *(common-emitter circuit)	20 V	—40 V (reverse bias)
I_C	Collector current (peak or d.c.)	10 mA	25 mA
V_{EB}	Reverse base-emitter voltage (mean or d.c.)	—1 V	—1 V
$I_{EB(pk)}$	Peak reverse emitter-base current	1 mA	1 mA
P_{tot}	Total device dissipation	100 mW	100 mW
T_{amb}	Ambient temperature range	—55 to +75°C	—55 to +75°C

* With $\frac{R_b}{R_e} < 100$ and $R_e > 200$ ohms

Circle **21** *for further details.*

Zone-refined Tellurium

JOHNSON MATTHEY are now producing zone-refined tellurium of high purity. The total metallic impurity content, excluding selenium, is less than 5 p.p.m. and is normally in the region of 1 p.p.m. The selenium content does not exceed 5 p.p.m.

Johnson Matthey tellurium is supplied as half-round bar approximately 1 in. × ½ in.

Circle **22** *for further details.*

Rare Earth Metals

JOHNSON MATTHEY are now able to supply scandium, yttrium, and most of the fourteen rare earth metals in sheet form in thicknesses down to 0·001 inch and with a maximum width of three inches. The sheet is available either cold worked or annealed.

This is the latest development in the company's production of the metals of this group, which have previously been available as ingots and in some cases as wire of diameters down to 0·02 inch.

Circle **23** *for further details.*

Magnetic Separator

RAPID MAGNETIC LTD. have available a new range of ANDOX 5 permanent magnet pulleys for extracting tramp iron from processed materials. The unit includes magnets made of anisotropic barium ferrite ceramic material, whose coercivity permits a radial pole construction as distinct from the axial disposition adopted with Alcomax magnets.

The superior field intensities so produced are equivalent to those of electromagnetic designs, with flux distribution patterned to conform to the burden contour on the belt conveyor. Highest intensity occurs at the centre of the conveyor where burden depth is greatest.

The pulleys are available in a range of sizes from 12 in. to 24 in. diameter for any belt width.

Circle **24** *for further details.*

Sub-miniature Lamp

A NEW 6-volt sub-miniature lamp for electronic and aeronautic applications is being marketed by the Special Products Division of Thorn Electrical Industries Ltd.

The lamp has a long life—well in excess of 10,000 hours. When derated to 5 volts, life expectancy is over 60,000 hours.

Capped and wire-ended versions are available and a lampholder has been designed to take full advantage of the small size of the capped version. For many applications the lamp may be wired direct to a group board or printed circuit.

The wire-ended lamp (L.1012) measures 0·218 in. long and 0·139 in. in diameter, and the overall dimensions of the capped lamp (L.1015) are 0·370 in. long and 0·182 in. in diameter.

Circle **25** *for further details.*

Water Meter

A NEW water meter is now available from Parkinson Cowan Measurement. Known as the Type 44, this compact meter has been fully tried throughout the world and has recorded more than 5,000,000 gallons under difficult water conditions.

As a result of investigations, all components of the Type 44 are made of materials selected specifically for their individual functions and are a successful combination of high mechanical strength with strong resistance to all forms of bacteriological and hygroscopic deterioration.

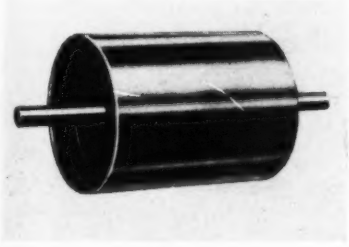
For instance, the measuring chamber is made of a precision moulded polyamide material which does not corrode and inhibits deposition. The chamber is protected from the abrasive effects of foreign matter by means of a filter, having a fine mesh and yet a large enough filtering area to minimise head-loss. All gears and pinions are made of a polyamide plastic and their stainless steel spindles run in self-lubricating bearings.

The two part screwed gun-metal casing, in conjunction with the absence of screws in the assembly of the Type 44 meter, means that components can be replaced, if necessary, without using tools of any kind. The use of gun-metal castings for the body gives maximum protection against corrosion by dezincification.

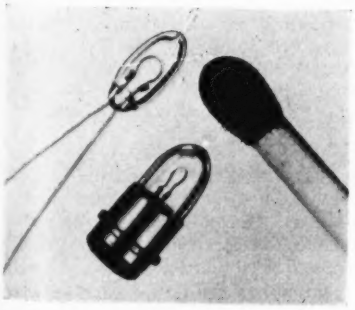
Available in the $\frac{1}{2}$ in. size with either wet or dry dial, the dry dial version being supplied with centre pointer or direct reading index, the new meter can handle without loss of accuracy flows of 400 gal/h at 10 ft head loss continuously for 24 hours a day. At flow rates as low as 5 gal/h the accuracy is guaranteed to within $\pm$ 2%.

The Type 44 is hydrostatically tested to 300 lb/in² and can sustain continuous working pressures of up to 150 lb/in².

Circle **26** *for further details.*



◀ *Permanent magnetic pulley with "Andox" magnets*



◀ *Capped and wire ended versions of the new subminiature lamp compared with a match-head*

Type 44 water meter ▶

Potentiometer/Voltmeter

To obtain greater accuracy in the commissioning of cathodic protection installations, and also for testing the output of magnesium and zinc anodes used in galvanic protection installations MAPEL have introduced a combined potentiometer/voltmeter with zero resistance ammeter ranges. Most meters used for measuring output of galvanic anodes provide false readings because they set up a resistance when connected into the circuit. When removed the voltage increases, which results in a shortened anode life and an inaccurate assessment of the cathodic protection installation.

The new MAPEL meter overcomes this difficulty and records accurately the current actually flowing in the anode circuit under normal conditions. Also, for measuring pipe-to-soil potentials with a half cell, a potentiometer/voltmeter has been included so as not to drain any current when measuring from the half cell, and again give a false reading. The meter has been specifically designed to incorporate potentiometer and zero resistance ammeter with one movement only.

The meter has circuits as follows:

1. High resistance voltmeter with full-scale deflection of 100 mV, 1 V, 5 V, 10 V, 50 V.
2. Potentiometer/voltmeter with an internal battery which enables potentiometric readings in the 100 mV, 1 V, and 5 V ranges to be made.
3. Zero resistance ammeter with ranges of 50 μA, 10 mA, 0·1 A and 1 A.
4. Normal ammeter ranges with full-scale deflection of 50 μA, 10 mA, 0·1 A, 1 A and 5 A.

The unit is contained in a wooden case measuring approximately 14 × 12 × 7 in. and is fitted with rubber pads on the bottom and a handle for carrying.

Circle **27** *for further details.*

Integrating Tachometer

A SIZE 15 integrating motor tachometer, Type 105P2Y, introduced by the Ketay Department, Norden Division of United Aircraft Corporation, is now available in the U.K. through Ketay Ltd.

This tachometer has high output-to-null voltage ratios and accurate performance over the extended temperature range —55 to 80°C.

Another valuable feature is the instantaneous response attainable since no warm-up time is required at any temperature within the operating range. The unit uses no heating elements, mechanical thermostats, amplifiers or external heat sources and, as a result, has the advantages of increased life, low weight and reduced power drain on the overall system.

Circle **28** *for further details.*

Miniature D.C. Relay

B. & R. RELAYS LTD. have just gone into production with a new relay which is the smallest in their range.

Styled the B.14, this inexpensive relay measures $1 \times 1\frac{5}{16} \times 1\frac{3}{32}$ in. and weighs 1 oz.

The B.14 has a maximum of one changeover silver or silver cadmium oxide contact, and the common contact is connected to the relay frame. The contact gap is 0·015 in. and the contact pressure is 8 grammes minimum. Nominal operating power is 100 milliwatts although the relay will operate at 80% of this figure.

The operating time at maximum power is 3 milliseconds.

Circle **29** *for further details.*

Protected Plug-in Relays

FOLLOWING the increased demand for plug-in versions of relays, B. & R. have recently developed two modified versions of their standard M01 and M51 models. The M01/P, which is the d.c. operated type, and the M51/P, which is its a.c. counterpart, are fitted with a protective cover for use in dust or particle laden air. The M01/PS and M51/PS are fitted with hermetically sealed covers, which is of particular interest where heavily polluted atmospheres are experienced, such as corrosive acid fumes. Both these relays have obvious applications in control systems for chemical and textile processes, together with many other industries where air cannot in all instances be kept clean. All four relays are mounted on octal type plugs with 8—14 pins, depending on contact requirements. These types measure some $2\frac{1}{2}$ in. high, by about $1\frac{1}{2} \times 2\frac{1}{4}$ in. across. The weight is 3 oz.

Circle **30** *for further details.*

Infra-red Scanning Systems

MANUFACTURED by the Radiation Electronics Corporation, and available in this country through West Instrument Ltd., THERMOPAN infra-red scanning systems remotely and rapidly scan an extensive area and present a visual image of the observed temperature pattern.

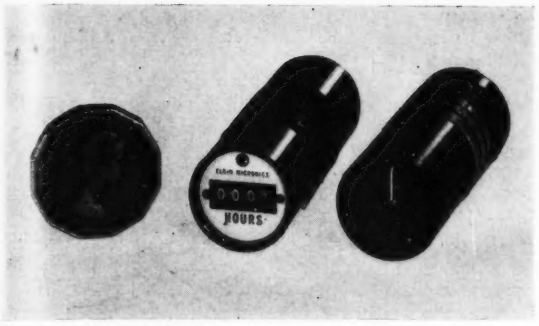
Basically, there are two types of equipment: the Model TP-2 for line scanning only and the Model TPA-5 for area or line scanning. The TPA-5, which uses a cooled infra-red detector, is generally required for scanning targets at about room temperatures but may also be used for warmer subjects being scanned at higher line rates. The output signals of both models is 10 millivolts, full scale, so that an oscilloscope or high-speed recorder may be used to display or record signals.

On the TP-2, a linear scanner which produces a " temperature profile " over a narrow strip, line rates may be selected from several seconds per line to 2,000 lines per second, according to the application. The TPA-5, for area scanning, consists of a scanning section, radiation thermometer and display equipment. The scanning section comprises a single plane mirror which is mechanically driven to scan rapidly in a vertical direction and more slowly in a horizontal direction, thereby generating a rectangular pattern similar to that of a television pattern.

Circle **31** *for further details.*

Elapsed Time Indicators

ELECTRO-MECHANICAL elapsed time indicators weighing about $1\frac{1}{2}$ ounces each are available from Aeromaritime Ltd. These miniature " electro clocks " record the precise operating time of electronic equipment and instrument systems, and are ideal for airborne systems and missile ground support applications, though their use for many other purposes can readily be visualised.



Elapsed time indicators

The need for elapsed time indicators of this standard has arisen as reliability requirements for complex equipment have received more and more exact definition in terms of operating time; elapsed operating times are used as the basis for maintenance and replacement schedules, and it has been proved that by basing such schedules on the true elapsed time, rather than on a cautious underestimate, the cost of spares and routine replacements can be reduced by as much as 50%. This saving during the lifetime of a complex apparatus repays the cost of the time indicator used many times over. Moreover, due to the extent to which miniaturisation has been achieved, the indicators can be used at little sacrifice in applications where space, weight and power are at a premium.

The indicators have either a dial or digital read-out, and will record up to 1,000 hours, though units for other time ranges are available. They are of cylindrical shape, with a diameter of 0·680 in. and length 1·42 in. (dial type) or 1·76 in. (digital type). Operation is by a synchronous electric motor and gear train available for single-phase, 400 cycles, 115 volt or 26 volt; there is also a 28 volt d.c. model. Power consumption is 1 watt.

Environmental standards provide for vibration up to 20 *g*, 10—2,000 c/s, with temperature limits of —65 to 250°F. All shafts rotating at over 5 rev/min have sapphire bearings; these have been tested at five times normal speed for three times normal life, with no measurable wear. The units are filled with an inert atmosphere to prevent deterioration by moisture, and are hermetically sealed. All coils are encapsulated in epoxy resin for total protection, and no shorting to earth occurs under operation within the specification conditions. The dial type is fitted with white hands and a black dial-face, and is readable to within 0·1%.

A similar unit is the events indicator, which will count up to 1,000 circuit activations, each as brief as 0·5 seconds in duration.

Circle **32** *for further details.*

"Thermodot" Radiation Thermometers

A RANGE of radiation thermometers under the trade name THERMODOT will be available in the United Kingdom and Eire, through West Instrument Ltd. Basically, the distinction is between high precision models for research and development and other types for constant production use. They are being widely used in America wherever it is necessary to measure temperature without physical contact.

Both types operate on the response of an infra-red detector which generates a signal voltage accurately proportional to the radiation density.

In the case of the Model TD-1, an optical chopper is used which may be stopped and transient phenomena as brief as 10 microseconds in duration may be observed, measured and recorded. With the Model TD-3, specifically designed for industrial use, the instrument is normally supplied with an indicator and indicating controller or recording potentiometer. The power supply is panel mounted and may be located some distance from the optical head.

Versatility is a marked characteristic of this equipment: the TD-1 will function from 100°F and the industrial TD-3 from 180°F.

Circle **33** *for further details.*

Pre-packaged Alarm Unit

WHEN instruments are installed, indication is usually required on a central control panel, and it is with this fact in mind that the "Add-on" alarm unit has been designed by Thomas Industrial Automation Ltd.

This unit can be supplied for either one, two or multipoint alarm systems, and, as its name implies, any number of these units can be added together to form a complete indicating system. They can be used with any form of instrumentation, for instance, temperature controllers, humidity controllers, pressure and level devices, etc., in fact any instrument which is capable of closing a pair of relay contacts when the danger condition is reached.

The single point system incorporates two signal lamps, one of which shows the safe condition. As soon as the danger condition is detected this safe lamp will be extinguished, and the danger lamp will be illuminated. If required an external flasher unit can be added which will operate only on the danger signal. At the same time as the danger lamp is illuminated an audible alarm would sound, and by the operation of a cancel alarm button the audible alarm would be silenced and the visual signal would change from a flashing to a permanent illumination.

The two point alarm system contains three signal lamps and works generally as described above, except that the safe signal lamp will be extinguished when either of the danger signal lamps is illuminated.

One of the unique features of this unit is that no matter how many units are added together only one audible alarm and one cancellation button are required. The rear of each unit is fitted with a connecting plug for inter-connection to adjacent units and to mains and external control circuits. It is complete with its own interlocking relays, utilises low voltage signal lamps for long life, and is fitted with a dustproof cover. Audible alarms of any type, flasher units and cancel alarm buttons can be supplied for use with these units.

The unit is designed for flange mounting on to existing or new panels. It is 3 in. wide by 6½ in. high, and the front panel is made of cadmium plate mild steel faced with Traffolyte, which can be engraved to customers' requirements.

Multipoint units can be supplied in wall-mounting cases of first-grade industrial finish.

The price of the " Add-on " alarm unit is as follows:

Single point — £17 19s. 6d.
Two point — £21 19s. 6d.

Cancellation button and audible alarm extra.

Delivery of these units is immediate.

Circle **34** *for further details.*

Multiple Level Controllers

To meet the growing demand for multiple level control panels at reasonable cost Elcontrol Ltd. have now produced a new double level control chassis which gives the same performance as the LR3, but which is smaller and can be readily supplied in multiple assemblies for comprehensive level control schemes.

This new LR8 unit is available in standard multiple assemblies to provide up to twelve separate level control or alarm stages, in steps of two—i.e. complete control cabinets are available for 2, 4, 6, 8, 10, or 12 controls. Larger numbers can easily be catered for by using two or more of the standard multiples, or alternatively special multiple cabinets can be supplied to order.

This new series offers the following advantages:

(a) Reduction in panel size
(b) Reduction in site wiring, since all interconnection is provided within the unit
(c) Testing and fault-finding made easy, as all external connections are made on one common terminal board
(d) Individual chassis easily replaced if necessary.

The basic unit is the LR8/2 chassis. This consists of a normal valve amplifier circuit assembled on a metal chassis, embodying its own transformer and power pack, and suitable for controlling the levels between two separate pairs of probes or for giving level alarm at two independent liquid levels. The principle of operation is the same as that of the existing range of units; the sensitivity is fixed and the mode of operation (A or B) is pre-wired at the works. It is therefore necessary to specify the mode when ordering.

The LR8 series of level controls are for use with any of the range of probe fittings, for open or pressurised vessels supplied by Elcontrol Ltd.

Unit	No. of Stages	Case No.	Dimensions	Price
LR8/2	2	11	$7\frac{1}{2} \times 6 \times 5\frac{1}{2}$ in. Projection	£18
LR8/4	4	24	$17\frac{1}{4} \times 9\frac{3}{4} \times 4\frac{11}{16}$ in. Projection	£32
LR8/6	6	23	$22\frac{3}{4} \times 18\frac{1}{2} \times 5\frac{1}{2}$ in. Projection	£45
LR8/8	8	23	Do. (Note: All these cases	£56
LR8/10	10	23	Do. are of sheet steel,	£67
LR8/12	12	23	Do. dust-proof and stove enamelled grey).	£78

Carriage and packing extra at cost.

Circle **35** *for further details.*

Test Equipment for Magnetic Systems

THIS equipment manufactured by Rese Engineering Inc., Philadelphia, has been developed for testing magnetic cores and memory systems. It is now available in the United Kingdom through Scientific Furnishings Ltd.

The equipment ranges from low cost manually operated units to completely automatic testers for cores, memory planes and entire computer memory systems.

The manual units include test jigs to facilitate laboratory testing of miniature ferrite cores and multi-apertured magnetic memory devices; high amplitude ultra-short pulse generators of variable frequency, jitter-free pulses with rise times of less than 5 nanosecs and amplitudes of up to 4 amp; and a precision voltage/current calibrator which provides a reference for oscilloscope analysis of d.c. or v.h.f. waveforms with an accuracy of 0·1% over a range of 1 mV to 200 volts and a bandwidth of 100 Mc/s.

The automatic equipment includes high speed mechanical memory core handlers with " accept " and " reject " grading facilities; programmed nanosecond current pulse generators; automatic memory plane testers which scan and test individual cores according to a preset programme, indicating faulty performance by digital presentation of the X-Y co-ordinates of the core (i.e. column and row). The memory system exerciser is an automatic high-speed digital computer simulator that tests and evaluates, for a wide range of operating parameters, complete memory systems in laboratory analysis and production testing. The memory exerciser simulates exact computer environment for testing, during the development, prototype and production stages of coincident-current and word organised core, multi-apertured, thin-film and similar memories. It is of modular construction.

The plug-in modules used in the memory exerciser form a complete range of 5 Mc/s and 200 kc/s logic blocks and are available separately.

Circle **36** *for further details.*

Digital System for Process Instruments

ROTAX LTD. have developed a system for the remote indication and recording of data from conventional process measuring instruments. The basis of the system is analogue to digital conversion at the instrument shaft without appreciable additional loading of the movement. This simple converter is inexpensive and can be fitted to pressure gauges and other instruments, converting them to digital transmitters.

Transmission of data readings can be automatic or on manual demand, either single or as part of a complete data logging system. Digital signals and control call-up signals are transmitted along two wires only and the power used has been kept low enough to satisfy Post Office line requirements.

Circle **37** *for further details.*

Resistance Thermometers

THE RdF STIKON resistance thermometers are supplied with adhesive sensing grids or with grids suitable for riveting and cementing. The RdF STRAPON resistance thermometer is mounted on a steel strap which is suitable for pipes and tubes.

These thermometers are characterised by millisecond response and will operate from near absolute zero to 2,000°F.

They are available from West Instrument Ltd.

Circle **38** *for further details.*

Paint Film Holiday Detector

In the case of thin paint films the standard type of high voltage detector is not suitable owing to breakdown of the thin film, and for this reason Mapel have developed a thin paint film Holiday detector. This instrument will very accurately determine pin holes, voids or bare spots in a surface coating with a very high electrical resistance when such material is brushed or spread on to an electrically conductive surface such as steel or concrete.

The Mapel paint film Holiday detector is not a spark detector, and is non-destructive. The applied voltage never exceeds 70 volts at any time. A flat sponge electrode measuring $\frac{1}{2} \times 6$ in. damped with clear water is the inspection electrode. When a fault is encountered in the paint film a small current leaks from the dry cell batteries and signals the presence of the fault by sounding a buzzer in the detector, together with a visual light indication on the unit. The design of the sponge electrode makes it possible to penetrate orifices and edges (where Holidays are most likely to occur). Full inspection is assured because the wet sponge provides a continuous liquid film over the coated area.

The whole unit is extremely light in weight and can be easily held in one hand. Two models are available, one with a pistol grip handle, and the other with a belt attachment which will not hamper the operator's activity on high structures where it is necessary to climb.

Circle **39** *for further details.*

Subminiature Silicon Glass Diodes

A range of new glass diode types is now available from International Rectifier Co. (Gt. Britain) Ltd.

Jedec Types 1N483A to 1N488A are high conductance types designed to meet military specifications, and will give 100 to 200 mA output current at 25°C, with maximum reverse current of from 0·100 to 0·250 microamperes at specified test voltage at 25°C. All units have an operating temperature range from −55 to +200°C, and feature glass-to-metal hermetic sealing for ruggedness and optimum reliability.

These diodes, which require the minimum of space, being only 0·110 in. diameter by 0·265 in. long, not counting leads, are available with p.i.v.s of 70 to 380 volts.

Circle **40** *for further details.*

Miniature Silicon Diodes

A series of miniaturised 750 mA rated diffused junction silicon diodes from International Rectifier Co. features low reverse current (200 μA) at rated p.i.v., surge current rating (50 amp peak, 1 cycle) and low forward voltage drop (0·92 volts) at rated current.

These axial lead diodes are primarily designed for industrial and T.V. applications where miniaturisation and high power handling capabilities are required.

The complete series, designated Types 5A2, 5A4, and 5A6, provides peak reverse voltage ratings of 200, 400 and 600 volts, and an operating temperature range from −65 to +130°C. An additional capability resulting from the new processing techniques is high diode mechanical strength. Each junction is encapsulated in a stable, high temperature non-metallic case, resulting in a superior environmental seal. Typical units measure 0·29 × 0·20 in. (dia.), not counting leads. Oversize silver plated copper leads ensure optimum heat dissipation.

Circle **41** *for further details.*

Corrosion Measurement

The Corrosometer, marketed in Great Britain and the Commonwealth by Winston Electronics, Ltd., on behalf of the Crest Instrument Co., Santa Fé Springs, California, U.S.A., gives a direct reading of the corrosion rate in less than a minute.

The instrument, which can be operated from the mains or battery, can measure the corrosion at a considerable number of points.

The probes consist of an exposed specimen of the material of which the pipeline, reaction chamber, or storage tank or laboratory sample is made, a reference specimen and a check specimen.

The reading from the probe is directly in micro-inches or centimetres on the meter without removal of the specimen, and the Corrosometer may be used for all metals and alloys.

The probe is based on the fact that the electrical conductivity of metals is very great, while that of non-metals is negligible by comparison. Thus the electrical resistance of the metal probe increases as the corrosion proceeds on its surface. The resistance ratio is then determined between the exposed specimen and a companion coated reference specimen made of the same metal.

A third short check specimen, also coated for protection, is used to verify the corrosion reading. Constant measurement between check and reference specimens shows that the protective coatings of the probe are intact. The test-point is compared with the three probes together.

The measurement is made while the process is in full operation, because once the probe is installed it need not be removed since, if the corrosion is carefully inhibited, the specimen will remain in place for months or even years.

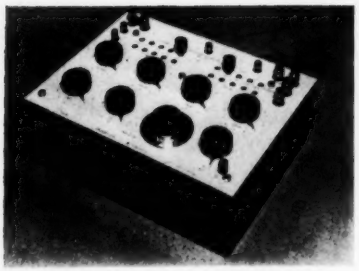
The Corrosometer itself may be installed in any convenient control room, since several hundred feet of extension cable may be used between the probes and the meter or used as a portable instrument for touring the plant or plants and taking readings regularly at probe points.

The Corrosometer is independent of the phase of the materials being processed or stored and these may be liquids, gases and semi-solids.

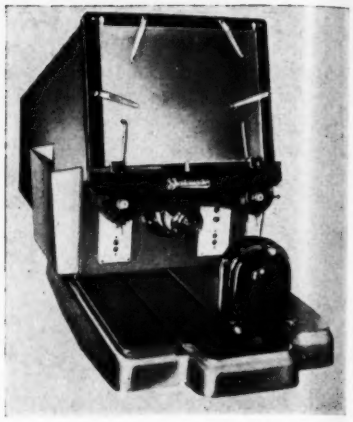
Probes can be constructed for all requirements and of all metals and alloys. In shape they can be of wire for long range testing, tube for short range testing where rugged construction is necessary, and strip for short range and laboratory testing. In size they vary from 1 to 80 millimetres thick for both short and long range testing. More than fifty alloys are maintained in stock to match construction metals.

The protective coating of the reference specimen can be of epoxy resin for low temperature conditions, fluorocarbon for medium temperature conditions and ceramic for high temperature conditions. The housings are of the suspension type for open systems, plug type

◀ *Corrosometer*



Precision Wheatstone bridge



Shadomaster projector

for closed systems where pressure seal is required withstanding over 5,000 lb/in². It is possible to retract the probe in pressure systems where the probe replacement may be required without shut down.

The meter is housed in a lightweight aluminium case with rim gasket and is power or battery operated. Its sensitivity is such that it will detect one-tenth of a microinch penetration of a 1-mil strip. The voltage on the probe is only 2 to 10 millivolts.

Circle **42** *for further details.*

Precision Wheatstone Bridge

A WHEATSTONE bridge from H. Tinsley & Co. Ltd. has a special design of rotary switches in the balancing arm which permits a precision hitherto obtainable only with plug switches. Six decade dials have a total of 111,111 ohms with least count of 0·1 ohm: a slidewire subdivides the 0·1 ohm step. Interchangeable plug ratio arms provide self-checking facilities.

The balancing arm consists of six decades having steps of 10,000, 1,000, 100, 10, 1 and 0·1 ohm. The 0·1 ohm increments are further subdivided by a slidewire which is readable to within 0·001 ohm, thus providing a discrimination to the order of 1 part in 10^8 when all dials are in use.

The use of high-grade patented "Dual Contact" copper switches of generous proportion with two sets of brushes make it possible to attain a degree of precision measurement comparable with a precision plug bridge. Exhaustive tests have shown that variation in contact resistance as the switch is moved from one position to any other does not exceed 10 microhms. The limit of uncertainty of resistance in the balancing arm is thus about 0·0001 ohm.

Each ratio arm comprises resistances of 10,000, 1,000, 100, 10 and 1 ohms selected by plug switches. Precision of adjustment is the same as in the balancing arm. In addition even ratio coils are adjusted to equality to a higher precision. Variation in plug contact resistance is less than 5 microhms.

The arms are conveniently interchangeable by further plug switches providing self-checking facilities.

It is well known that there is an inevitable drift in the resistance of coils especially during the first year or so of use. Although small, the drift may be significant in an instrument of this precision. It is recommended that the bridge be returned to the factory for checking after the first year. As a guide, the expected drift during the period is expected not to exceed 10 parts per million.

The Tinsley Type SR4/4500 null-detector with a 50 ohm suspension is recommended. For the highest precision and in order to reduce the bridge current, the galvanometer-photocell amplifier, thermal compensating and sensitivity control unit and indicating galvanometer SS2/45E are preferred.

Circle **43** *for further details.*

Shadomaster Projector

THE Shadomaster Model BC 1512 true-gauge projector has been designed, primarily, for optical gauging applications, and is the latest instrument in the Shadomaster range from Watson, Manasty & Co. Ltd.

Four double pole, press action switches are fitted, the first being a master switch in the mains circuit with red warning light. The remaining three switches are in the secondary circuits controlling the profile lamphouse and, independently, two surface illumination lamphouses (the latter are not shown in the illustration but the plug-in points are clearly visible on the front face of the projector).

The Model BC 1512 has a spacious working area for the mounting of large gauging blocks and fixtures. The special chart rest has provision for rigid location of glass overlay charts of varying sizes and is provided with coarse and fine adjustment in both planes.

Magnifications:	10×, 15×, 20×, 25×, 31·25×, 40×, 50×, and 100×
Screen size:	15 × 12 in.
Work area:	17½ × 16⅜ in. precision ground cast-iron bed-plate with three tee-slots
Illumination:	Specially designed lamp with high intensity output

Accessory interchangeability: The projector is collimated to the same precision limits and standards as the Shadomaster Models VMP measuring projector, both 2 and 4 in. types, and CRP Mk. II. A wide range of accessories is, thereby, directly interchangeable.

Applications: Repetition optical gauging and angular measurement applications, diascopically and/or episcopically.

Circle **44** *for further details.*

Oscillating Hotplate

THE simultaneous heating and stirring of liquids at a constant temperature for analytical and preparative work in industrial, educational and medical research and control laboratories can now be achieved quickly by the use of the Griffin oscillating hotplate.

The hotplate accommodates twenty-eight 250 ml or eighteen 400 ml Griffin beakers, and oscillates in a circular orbit of $\frac{1}{8}$ inch, 216 times a minute. Powdered solids can be prevented from settling and dissolve more rapidly in solvents, while immiscible liquids are kept in intimate contact with each other and can react at a reasonable speed. Spattering is eliminated in the evaporation of neutral and acid solutions, and partially with alkaline solutions.

The heating is governed by a Simmerstat regulator which permits a range of hotplate surface temperatures suitable for most heating operations in general analysis up to a temperature of 650°F (350°C).

The hotplate is heated by two steel-sheathed heating elements cast in the shape of an extended S. This construction results in an even temperature over the complete plate surface.

The oscillator is driven by a gear-reduced motor with tropicalised winding and an eccentric driving shaft for moving the hotplate.

The motor is set in a cast-iron base and stands on rubber feet. The weight of the base and the friction between the rubber feet and the bench top prevents creeping.

The hotplate rating is 2,000 watts at 240 volts.

Circle **45** *for further details.*

Mixing Cycle Controller

LINDARS AUTOMATION LTD. have recently received a contract for a fully automatic mixing cycle controller. The equipment, which is entirely of their own design, is suitable for use in conjunction with a Banbury or similar mixer, the complete mixing cycle being programmed from a punched card. Function variables, such as time and temperature, can be adjusted in increments of 5 seconds and 5 degrees respectively and quantities of oil in increments of one hundredth of a gallon. The sequence of operations is infinitely variable.

The mixing cycles can be changed in a matter of seconds, it being merely necessary to select the appropriate pre-punched card and insert it into the Lindars card reader. This flexibility of operation makes the system suitable for use with mixers engaged on small batch production, especially where large numbers of different compounds are involved.

Circle **46** *for further details.*

Ultragraph Recorder

DIRECT recording of high speed physical phenomena within the frequency range of d.c. to 5,000 c/s is possible with the Ultragraph from the ABEM Co., of Stockholm.

Up to fourteen independent channels are available for recording stress, strain, vibration, oscillation, displacement, pressure and temperature changes, or other related events capable of conversion to electrical voltage.

Designed for use in research and industry, the instrument incorporates ultra-sensitive galvanometers, measuring only 75 mm by 6·5 mm in diameter, which dispense with the need for intermediate amplifiers for many applications.

The Ultragraph employs a high pressure mercury vapour lamp, and recordings are made on ultra-violet sensitive paper; no processing is required and the traces print out almost immediately.

Smiths Industrial Division are the sole distributors of ABEM recording equipment in the U.K., U.S.A., the Commonwealth and certain European territories.

Circle **47** *for further details.*

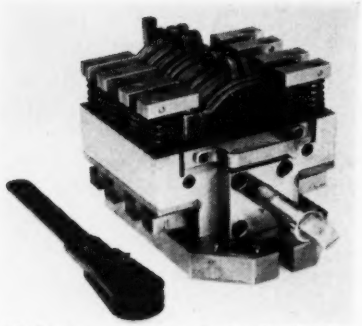
Work-clamping Devices

WITH the introduction of a range of hydraulic vice jaws and clamping fixtures, designed and manufactured by Larrad (Hydrajaws) Ltd. and distributed in England and Wales by Alfred Herbert Ltd., many of the limitations imposed by the normal vices and clamps are eliminated.

The Hydrajaws are simply constructed and employ the well-known principle of the uniform distribution of an applied pressure throughout a liquid. In essence, they consist of mild-steel blocks, suitable for inserting in the machine vice, and are provided with a series of protruding plungers with which the workpiece is gripped. The spaces behind the plungers are filled with hydraulic oil and are interconnected, thereby enabling the plungers to adjust themselves automatically to the contour of the workpiece as the vice is being closed, and also to exert equal pressures, when the vice is fully tightened. In practice it has been found that, in addition to applying equal pressures, the clamping effort of each plunger, when the vice is only moderately tightened, is greatly in excess of that applied by the vice alone.

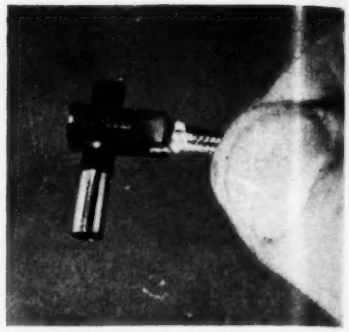
A range of eight standard Hydrajaws is available with a choice of six designs of plunger heads. The smaller sizes of Hydrajaws can be supplied with matching multiple-vee blocks, suitable for holding a number of small components, or with vee-blocks having a single horizontal vee.

Operating on the same principle as the Hydrajaw units is a further range of six Hydrajaw clamps, resembling in appearance the conventional solid jig-and-fixture clamps. The advantage of the Hydrajaw clamp is that in place of the normal solid clamping pads



Hydrajaw clamping device for holding four bearing caps whilst a slot is milled in the top of each

Transistorised photo-electric equipment



Miniature pressure transducer

there is a row of clamping plungers, again interconnected by hydraulic oil giving fully compensated clamping. The use of spherical seatings and washers is completely unnecessary with a Hydrajaw clamp.

A logical development of the vice jaws and clamps described above is the design of a series of Hydrajaw fixtures. In these the pressure is applied to the fluid by means of a screwed master plunger embodied in the unit, otherwise the principle is the same, namely that of a hydraulically compensated, closed-circuit, multi-point clamping unit. Irregularly shaped components or a number of small components can thus be held by one Hydrajaw clamp actuated by turning a single screw. Conventional methods of holding these components with a series of small clamps each having a separate clamping screw can now be eliminated and considerable reductions in floor-to-floor times are effected.

Circle **48** *for further details.*

Transistorised Photo-electric Equipment

A NEW Series TPU.1 range of transistorised photo-electric equipment is available in alternative versions for counting or switching applications from Lancashire Dynamo Electronic Products Ltd.

When used for counting applications, the unit is supplied complete with a Series F.43 electromagnetic counter, which is energised directly from a transistor switch circuit. In this configuration the unit is designed to operate up to a speed of 1,500 counts per minute. Six figure indication gives a total of 999,999 counts and manual reset facilities are provided.

In those applications where photo-electric switching is required, the unit is supplied with an integrally mounted relay having one pair of normally open and one pair of normally closed contacts rated at 3 amperes at 230 volts a.c. In this configuration the unit is suitable for operation at switching rates up to 300 per minute.

When used in conjunction with the standard 8 watt remote mounting light source unit, both versions are suitable for operation over a range of 25 feet. The light source unit obtains its supply directly from the photo-electric unit and no additional supplies are required.

The Series TPU.1 range of equipment is suitable for operation from 100/115 or 200/250 volts, 50 cycles supplies.

Circle **49** *for further details.*

Miniature Pressure Transducer

A DIFFERENTIAL pressure transducer, measuring only $\frac{3}{8} \times \frac{1}{4} \times \frac{1}{8}$ in., is being produced by New Electronic Products Ltd.

The transducer was developed by the Instrumentation Department, Royal Aircraft Establishment, Farnborough, for plotting static and dynamic pressures on wind tunnel models. It is likely to find applications in many fields of investigation and design, owing to its very small physical dimensions.

This new miniature pressure transducer operates on the variable capacity principle. Two chambers are separated by a diaphragm which deflects under pressure, varying the capacitance between itself and two insulated electrodes. Zero drift is less than 0·15% per °C; rise time is 15 μsec, with a high carrier frequency.

Two pressure ranges are available, ± 4 lb/in² and ± 10 lb/in². Others are under development.

The transducer is used in conjunction with an a.c. bridge with close coupled inductance ratio arms, a carrier amplifier, and a phase sensitive demodulator.

The voltage output of ± 4·5 V, developed across an impedance of 3 k ohms, may be applied to any suitable indicator or recorder.

Circle **50** *for further details.*

Twin-filament Indicator Lamp and Lampholders

A NEW addition to the Thorn range of indicator lamps is a twin-filament warning indicator cap which can be fitted to any of the standard $\frac{3}{8}$ in. thread lampholder bases in this series.

Two separate filaments are embedded in a translucent cap with an opaque divider placed between them. In normal use both filaments evenly illuminate the cap, but should failure of one filament occur, the lamp will remain half-illuminated for warning purposes and at the same time indicate the need for lamp replacement.

Should it be necessary to provide some indication of function, characters can be engraved on the flat top of the translucent cap, which is rotatable to ensure that the figures or letters are upright when the lampholder is screwed home.

Two shank lengths are provided—one for flush panel mounting and the other for use in standard " Plasteck " panels. Cap colours available are red, green, amber and ivory. Dimensions are: diameter $\frac{3}{4}$ in. overall, depth $1\frac{1}{32}$ in. Depth of the long-shank type is $1\frac{9}{32}$ in.

Another addition to the Thorn range is a waterproof and pressure-resistant miniature sealed glass lampholder, designed for heavy-duty use—particularly in military equipment such as tanks where it will resist shock and impact damage to a high degree.

The lampholder is designed to meet the requirements of Ministry specification DEF 5201, Style LH23, and will fit into the panel holes required by that specification. The shell of the lampholders is insulated from both contacts, and designed for single-aperture mounting.

Stout tubular terminations with solder buckets project through the high temperature seals in the base of the lampholder, and give solid, robust connection.

Indicator and neon indicator caps are available as alternative versions of the lamp in a variety of colours.

Circle **51** *for further details.*

Video Target Simulator

A MOVING video target simulator, manufactured by Romanco Incorporated of California, will be used by the R.A.F. and Government Research Laboratories. It is to be marketed in the U.K. by B and K Laboratories Ltd.

The RP 175 PM is a target simulator designed for use with modern precision instrumentation radars and fire control radars.

The equipment features video pulses that may be manually positioned, either programmed in range at constant velocity, or programmed from an initial velocity to a final velocity at predetermined accelerations. To ensure the accuracy of the programmes running many minutes in duration, the programmer section computer has been chopper stabilised.

Provision has been made for mixing i.f. noise and for amplitude modulating the pulse to simulate the effect of radar scan or of target fades. The equipment is in module form, containing four removable modules and a test cable is supplied to enable easy servicing of each module.

Additional features which can be incorporated in the RP 175 PM are built-in noise generators, continuously variable pulse widths, frequency modulated pulsed r.f. signals, automatic recycling of range programmes and pulsed i.f. target signals.

Circle **52** *for further details.*

Oil Burner Time Delay Solenoid Valve

AN oil burner time delay solenoid valve has recently been introduced by the Skinner Electric Valve Division in the 2 way " C " series.

Designated C2-XII, the valve has a $\frac{1}{16}$ in. orifice and is suitable for controlling pressures up to 170 lb/in² of fuel oil between 750 and 950 Redwood No. 1.

The delay action of 5-7 seconds is effected by a resistance in series with the windings of the coil. The whole unit is contained in the same physical dimensions as the standard valve.

The main body, of brass, has stainless steel internals and sleeve assembly, the valve insert is of HyCar high heat resistant rubber, giving bubble-tight closure under all conditions. The coil housing of chromated mild steel is available with various electrical connections, coil voltage 110 or 230 volts a.c.

It is available from British Arca Regulators Ltd.

Circle **53** *for further details.*

Visual Decade Counting Units

THE Winston visual decade counting units, manufactured by Winston Electronics Ltd., count impulses up to a maximum rate of 40,000 per second.

The Winston decade unit may be used for counting pulses in any form of electronic counter. The field of applications includes packaging, machinery, mass produced outputs for both the end product and the intermediate process stages, machine shops, pressing shops, the counting of measuring units, and, in fact, wherever counting of any number for measurement is required.

When the pulses to a unit are stopped the digital display reached with the last pulse can be held indefinitely until the unit is reset with a signal fed from associated circuitry.

The unit is constructed as a plug-in module which connects with its associated circuits through a standard octal plug. The digits are displayed through a translucent Perspex panel showing white numerals against a black background. These numerals are $\frac{7}{32}$ in. (0·2 cm) high and are of uniform intensity.

The circuit is basically made up of four binary counter stages. Normally a circuit of this type would accept and record sixteen input pulses before returning to its original condition (recycle). However, two internal feedback circuits between stages cause the counter to advance six counts without recording. This allows the counter to recycle after ten input pulses which provides the desired decade counting feature.

Technical Specification

Max. counting rate	40 kc/s
Resolution	8 microseconds
Input requirements	Negative pulse
Amplitude	50—150 volts
Min. pulse width	0·5 microseconds
Max. rise time	1·5 microseconds
Impedance	100 μF in series with 25,000 ohms approx.
Output	
Waveform	100 volt negative transient
Impedance	68·00 ohms
Max. load	100 μF in series with 13,000 ohms
Power requirements	6·3 volts at 1·2 amp + 300 volts d.c. at 9 mA
Valves	4 Type 5963
Dimensions	$1\frac{1}{2} \times 5\frac{1}{2} \times 5\frac{1}{4}$ in.
Weight	$\frac{3}{4}$ lb approx.
Mounting	Octal socket.

Circle **54** *for further details.*

Variable Phase Adaptor

THE variable phase adaptor Type 446 is intended for use in conjunction with quadrature output oscillators such as the Dawe Type 442 and Type 445. With 0° and 90° inputs applied to the Type 446, multiple fixed phase

outputs and a continuously adjustable single phase output are available to study the performance of single and multi-phase circuits.

The circuit consists essentially of eight d.c. coupled phase inverters feeding a continuously variable potentiometer with balanced signals at eight symmetrically spaced terminals. The eight phase signals are derived from quadrature input signals of 0° and 90° phase. By phase inversion 180° and + 90° signals are first obtained and then by symmetrical cross-coupling between each pair of the four phases the four intermediate phases are derived. The six phase output is derived from a symmetrical phase division of the four phase output. The accuracy of the phase calibration of output signals depends mainly on the phase accuracy of the quadrature inputs. The d.c. drift is negligible as a result of high feedback factors in the unity gain operational amplifiers. The instrument is mains operated, compact and portable.

Specification

Frequency range:	d.c. to 10 kc/s
Input:	Accurate quadrature signals of up to 5 V r.m.s.
Variable phase output:	Continuously variable linear scale 0—360° calibrated to ±2°. Output at unity gain constant to within ±5%. Minimum load resistance 20 kΩ.
4 and 8 phase outputs:	Accuracy ±1°. Phase amplitudes pre-set to equality at unity gain. Minimum load resistance 2 kΩ.
3 and 6 phase outputs:	Accuracy ±1°. Phase amplitudes with ±3% at unity gain. Minimum load resistance 2 kΩ.
Distortion:	Less than 2% when used with the Type 442 or Type 445 oscillators. Hum and noise less than 1%.
Power supply:	110 V and 200-250 V, 50-60 c/s, 100 W approx. Compact portable metal cabinet finished black with polished metal bezels.
Dimensions:	8½ in. × 13 in. × 12½ in. high (210 mm × 330 mm × 320 mm).
Weight:	18 lb approx. (8 kg).

Circle **55** *for further details.*

Meters for Severe Environments

A LINE of long-scale, three-inch edgewise d.c. and a.c. meters has been developed by the American associates of Honeywell Controls Ltd. for use in control console and equipment applications needing reliable indications in severe environments.

The new instrument, hermetically sealed, is available in a broad selection of d.c. current (200 micro-amperes and up) and voltage ranges, as well as in rectifier-type a.c. styles. The mechanism is shielded and the panel has no influence on calibration.

The instrument, known as MDE-3, may be mounted horizontally or vertically. Its case size (3·7 by 6·1 by 1·3 inches) makes it possible to mount the meters close together and to obtain in-line read-out.

Circle **56** *for further details.*

P.D.A. Cathode Ray Tube

THE LD603 5-inch cathode ray tube has an X-deflection sensitivity of 9·5 V/cm and a Y sensitivity of 3·7 V/cm under the following operating conditions:

$V_{a1,a3}$	1·5 kV
V_{a4}	10 kV

Post deflection acceleration of the electron beam in a cathode ray tube increases trace brightness without incurring the loss of sensitivity that would result from an increase of final anode potential. As existing post deflection accelerators are not completely efficient, some loss of deflection sensitivity and scanned area occurs. By mounting a mesh about an inch behind the screen this loss is eliminated and the p.d.a. becomes 100% efficient.

In the LD603, this principle has been employed to produce a tube possessing three times the deflection sensitivity of helical p.d.a. tubes while maintaining a scanned area of 10 cm × 6 cm.

Circle **57** *for further details.*

Photo-electronic Control for Artificial Lighting

THIS new control Type BTL/2 from Photoelectronics (M.O.M.) Ltd. is so designed that any number of units may be combined to control several independent circuits where differing internal daylight conditions exist. Each control circuit is provided with two setting controls—one to determine when the lights are to be turned off and the other the point at which the lighting is brought on again, thus the mean area of control is readily adjustable to suit local requirements. Indicating lamps show the state of the control at any particular time and enable the unit to be set up independently of the lighting circuits if desired.

The photocell is normally mounted externally in its weatherproof housing with the controller mounted in any convenient internal position.

Any number of controllers can be provided to operate different lighting circuits so that the lighting in in a whole factory or office block can be regulated according to individual needs from one control panel.

Time clocks and appropriately rated contactors can also be provided in the control panel. Once set up the controller is fully automatic in operation.

Price: £35 complete per individually controlled lighting circuit.

Delivery: 4—6 weeks.

Circle **58** *for further details.*

Miniature Moving Coil Relay

THE MICROTACT hermetically sealed miniature moving coil measuring relay has been introduced by Leland Instruments Ltd. It provides a sealed version of the Sensitact moving coil measuring relay.

The new MICROTACT relay comprises a screened moving coil galvanometer, of which the moving coil is fitted with a moving contact which engages with fixed contacts at either end of the arc of travel. The whole assembly is enclosed in a cylindrical metal container which is mounted on a standard seven pin miniature valve type base and hermetically sealed. The complete relay is 40 mm long, 20 mm diameter and weighs approximately 1·12 oz.

The relay is available with three alternative windings —2,500 ohms, 125 ohms and 2·5 ohms, giving full-scale deflection sensitivities of 50 μA, 250 μA and 2·5 mA, and in each case the relays are offered either with centre zero or in the conventional minimum/maximum arrangement. In the case of the minimum/maximum types, when no current is flowing through the moving

coil, the moving contact remains at rest against the fixed "minimum" contact. In the case of the centre zero types, when no current is flowing the moving contact remains in the centre zero position, both minimum and maximum fixed contacts remaining open.

In view of the hermetic sealing the adjustable "fixed" contacts have to be preset at the time of manufacture and in the case of the most sensitive model—Type 191—the minimum contact is normally advanced to a point equivalent to a current of 5 μA. At this and higher currents the moving contact moves away, opening the minimum contact. Both the minimum and maximum contacts then remain open until a full-scale deflection current of 50 μA is reached when the moving contact closes to the maximum fixed contact. In the case of the centre zero edition of this model the currents at which the moving contact closes to the minimum and maximum contacts are ±25 μA.

Corresponding currents for the other two standard models are—Type 196: 25 and 250 μA (± 125 μA for the centre zero edition), and for the Type 164: 0·25 and 2·5 mA (± 1·25 mA for the centre zero edition).

The precision with which these relays open and close at the required currents is of the order of ±1·5% of full-scale deflection current.

Response time of the MICROTACT relay is $\frac{1}{10}$ to $\frac{1}{2}$ a second, depending on the particular model and the positions at which the contacts are set.

The power handling capacity of the contacts is 30 mW at a maximum voltage of 20 volts d.c. or a.c. The employment of this relay therefore requires the addition of a secondary relay of lower sensitivity and precision, but having a higher power handling capacity. A suitable range of electro-magnetic models is available, or alternatively the MICROTACT may operate an electronic valve.

Circle **59** *for further details.*

Ionisation Chamber

PLESSEY NUCLEONICS LTD. has produced a new ionisation chamber (PNI 1091) which when used with a mixed argon-nitrogen filling enables the response to gamma radiation to be made level down to about 100 keV. Below this figure it drops sharply.

The chamber can be made sensitive to thermal neutrons if required, and can be filled to provide approximate tissue equivalence to fast neutrons over a wide energy range.

The sensitive volume is 5 litres, and various filling gases can be used at pressures up to 20 atm. A rigid electrode structure ensures low microphony, and robustness is given by ceramic insulators and ceramic-to-metal seals.

Specification

Sensitivity (20 atm argon filling) $1{\cdot}3 \times 10^{-8}$ A/r/h
Sensitivity (20 atm mixed filling) $7{\cdot}7 \times 10^{-9}$ A/r/h
Maximum polarising potential 3 kV.
Circle **60** *for further details.*

Portable Double-beam Oscilloscope

THE CT 436 is a portable double-beam oscilloscope, designed by Solartron to meet the rigorous K114E test specification. It operates either from 45—400 c/s a.c. mains or 24/30 V d.c. and weighs 28 lb.

The CT 436 has two separate Y channels (d.c.—6 Mc/s); each channel having its own set of controls for independent setting of the traces on the double-gun c.r.t. Y_1 and Y_2 amplifier sensitivities of 100 mV/cm to 100 V/cm are covered in 10 ranges (switched in 1-2-5 sequence) with ±5% accuracy. An additional 10× gain gives a maximum sensitivity of 10 mV/cm (3 c/s—500 kc/s). Continuous coverage is provided by a fine gain control. 0·4 μsecs signal delay (on both channels) permits leading edges of fast pulses to be examined. Two diameters of Y shift is provided and the Y plates are accessible.

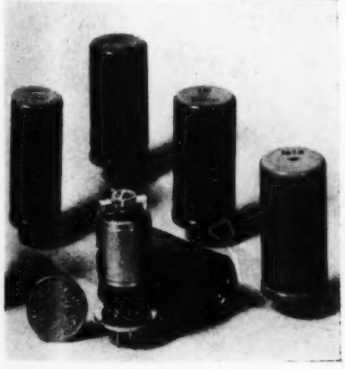
The 1 cm/μsec to 2 cm/sec time-base, covered in 18 calibrated ranges (switched in 1-2-5 sequence), may be used in the repetitive, triggered, or auto-triggered modes. A fine control, with a calibration position, provides continuous coverage. The measuring accuracy is ±5%. "Level" and "Stability" controls enable the sweep to be triggered from any selected point on the triggering waveform. The time-base waveform is available at output sockets (approximately 15 V peak-peak via cathode follower, 150 V peak-peak at high impedance for driving sweep generators). X-shift enables either end of the trace to be centred at all settings of X gain control. External signals may be applied to the X-amplifier (d.c.—500 kc/s), input impedance 1 MΩ/30 pF. Sensitivity is continuously variable from approximately 0·2 V/cm to 2 V/cm.

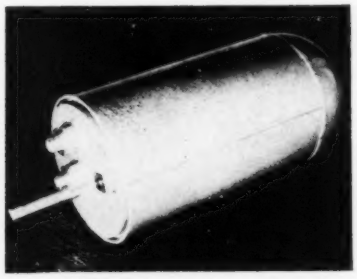
A 1 kc/s square wave of 0·5 V peak-peak ±1% is available for calibration. This waveform is available at 7·5 V for setting probes. Brilliant displays of

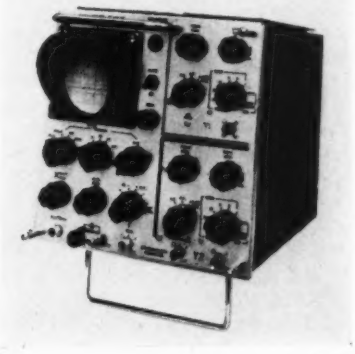
◀ *Microtact relay*

Portable double-beam oscilloscope ▶

Ionisation chamber







excellent definition are provided by a double-gun c.r.t. 3AZP31. The stabilised e.h.t. (1·75 kV) ensures that calibration is independent of brightness levels. External brightness modulation facilities are provided: 5 volts peak-peak applied to the grid of the c.r.t. fully modulates the traces. The edge illuminated graticule is calibrated in centimetres with 2 mm sub-divisions.

Oscilloscope CT 436 is powered either by 100/125 V, 200/250 V, 45—400 c/s mains or from 24/30 V d.c. using special plug-in d.c. converter. The mains lead can be connected at the rear of the instrument for normal operation or through a side panel when it is required to operate the oscilloscope on its back.

Circle **61** *for further details.*

Automatic Multicore Connector Tester

THE AMCT is a fully automatic designed apparatus for testing:

1. the continuity of the cores or conductors
2. leakage between the different cores in the cable
3. leakage between cores and the screen of the cable.

The apparatus is particularly intended for the rapid testing of multicore cables, e.g., coming off a production line, and with multi-way connector members in the form of plugs or sockets.

It comprises:

1. two sets of indicators
2. two selectors, each selector controlling the connections to one of the sets of indicators, and also to the cores of the cable
3. means for connecting a multi-core cable to be tested to the apparatus
4. switches for applying test potentials to the cable to be tested
5. means for controlling the switching of the selectors. The arrangement is such that the testing cycle is interrupted if a fault is discovered, and the indicators indicate with which conductors of the cable the fault is associated.

The apparatus can also be used to test the electrical continuity of the screen of a cable and also test for leakage between the cores of the cable and the screen, as well as measuring the value of the leakage.

The two rotary selector switches are driven by means of solenoids, the arrangement being such that upon the satisfactory completion of one test, solenoids operate to step the selector switches to the position connecting the next core of the cable to be tested with the testing circuits. The apparatus also includes relays controlling the inter-connection of the circuits with the selector switches.

Indication is by lamps, one for each core of the cable to be tested.

The equipment is available from PCA Radio Ltd.

Circle **62** *for further details.*

Domestic Water Meter

GEORGE KENT LTD. have produced an ebonite working chamber version of the brass ½ inch JSM domestic water meter, which they introduced in May, 1960.

The new meter, which is to be known as the Kent ½ inch SM, incorporates all the features of the Kent JSM improved rotary piston type meter and may be used where the water supply tends to be corrosive.

Kent water meter
Left—with flap raised to show straight reading counter
Centre—unscrewed to show working chamber and worm drive
Right—combined reduction gear and counter unit located by a sprung wedge

Both piston and working chamber are of ebonite and will provide long life, without loss of performance or accuracy.

The new ½ inch SM meter sells in the United Kingdom for £4 7s. 6d. which is the same as its alternative, the ½ inch JSM. It is expected that ¾ inch and 1 inch versions will be introduced later.

All international standard body lengths and end-threads can be accommodated. Registration may be in gallons or cubic metres.

The Kent SM and JSM meters feature the following design points:

(1) One simplified counter and reduction gear unit, fully sealed and glandless, replaces the conventional counter mechanism, under-gear and joint plate with gland. All counter parts run in a clear, corrosion inhibiting lubricant maintained at the internal pressure of the meter by means of a compensating membrane.

(2) All gears are in moulded graphited nylon, having a low water absorption characteristic.

(3) The design of the meter has been so simplified that only two screwed threads are used in its construction, with consequent ease of servicing and negligible maintenance costs.

(4) Water flow through the meter undergoes six fewer changes in direction—resulting in a compact meter with maximum capacity.

(5) The SM meter is approximately half the bulk and weight of comparable ½ inch meters.

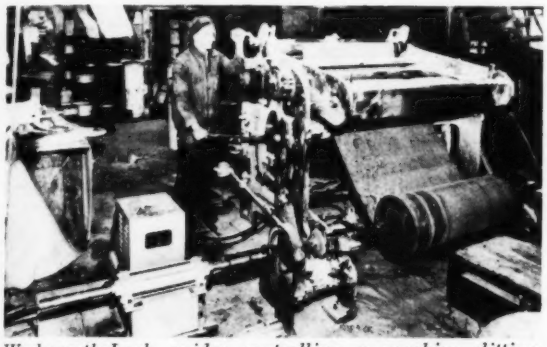
Circle **63** *for further details.*

Wadsworth-Lock Edge/Line Guider

EDGE trim can be eliminated, speed of manufacture increased and the quality of the finished product greatly improved by automatically positioning the edge of reel-fed materials. The new Wadsworth-Lock edge or line guiding equipment consists basically of a sensing head and a completely independent, hydraulic ram control unit which is capable of adjusting very quickly in a lateral direction the position of reels weighing from a few pounds up to several tons. Alternatively, webs of moving material can be positioned by using the hydraulic ram unit to operate a roller guider.

A number of edge or line sensing units are available including a pneumatic detector and a fully transistorised electronic print line tracking unit which can guide a web at speeds up to 1,500 feet per minute from a continuous or broken line printed on the web.

Circle **64** *for further details.*



Wadsworth-Lock guider controlling a machine slitting roofing felt

Symbol Printer

THE Symbol printer, when used with the Bryans' X & Y co-ordinate plotting table, allows plotting of various identifiable point plotted curves on one chart. It can be incorporated in data plotting systems from punched cards, punched tapes or point plotters.

The imprint of a selected symbol is accomplished by a solenoid-actuated die through an inked ribbon. Dies are inserted manually into the printing unit and once in position the operation is automatic from the actuating source. (Provision is made for stowing the dies when not in use.)

The plotting rate is 60 points per minute maximum.

A standard set of 6 symbols is provided. Additional symbols can be supplied to special order.

Circle **65** *for further details.*

Gas Meters

Two new gas meters designed specifically for industrial installations using gas at pressures up to 100 lb/in² are now being made and marketed in this country by Parkinson Cowan Gas Meters.

Both meters—the B 1200 and B 2000—are unit-constructed and can easily withstand the maximum working pressure of 100 lb/in².

Capacity per revolution of the B 1200 is 0·5 ft³; capacity per revolution of the B 2000 is 1·25 ft³. Capacity of the B 1200 and B 2000 at 0·5 in. w.g. pressure loss is 1,000 ft³ and 1,500 ft³ respectively on air. The capacities at 2·0 in. w.g. pressure loss are 2,000 ft³ and 3,000 ft³.

Outer cases of the new meters are cast aluminium silicon and have only one main gasket joint. The index on both meters registers up to 10 million ft³ and can be positioned to allow the meter inlet to be on the right or left hand side. A 10 ft³ test dial is fitted to both models.

The measuring units of the meters consist of four chambers enclosed within two pairs of diaphragm pans, the pans being specially shaped to ensure consistently accurate registration. Valve covers and seatings in the measuring units are made of a wear-resistant material and are completely self-lubricating.

A special feature common to both new meters provides a simple method of fitting various standard volume and base pressure gauges to the meter index without an adaptor platform, the back plate of the index being slotted to take the gauge drive arm. The slot has a swivel cover to protect the index mechanism when the gauge is removed.

Circle **66** *for further details.*

Continuous-Check Flame Safeguard

A FLAME safeguard unit that checks its own complete circuit once every second is announced by Honeywell Controls Ltd.

A self-checking circuit disconnects the flame rod and checks all components every second. Such checking has hitherto been incorporated in combustion safeguards during start-up or re-cycling only. The new type, known as the R 4075 Protectoglo, will cause immediate shut-down and sound an alarm if the sensing signal, amplifier or related circuitry fails at any time while burners are operating.

Circle **67** *for further details.*

Muntz Direct Flow Indicators

SINCE the introduction of additive-oils the difficulty of indicating small flows has become increasingly apparent. In some cases the characteristics of the oil are such that the conventional type of flow indicator will not work at all. In others reasonable results can only be obtained if the glasses are removed at frequent intervals for cleaning and maintenance. It is of course possible to obtain accurate measurements by using special flow meters. These are virtually laboratory instruments and are inevitably extremely expensive.

The Muntz direct flow indicator, which operates on the ball and tube principle, has been developed to overcome these difficulties. The indicator consists of a ball in a transparent tube with a tapered bore, so arranged that as the flow increases the ball rises in the tube. An indication of the actual flow rate is therefore obtained.

The current types include:

(a) Two standard single indicators, suitable for inclusion in any oil line

(b) A multi-point panel designed for use where a large number of indicators is required. All the units are grouped together and it is thus possible to check the various flows almost at a glance.

(c) A replacement indicator which can be substituted directly for other types of sight glasses

(d) Two types of indicators for large oil circulating systems.

The Muntz flow indicators contain no special liquids, thus there is no contamination of the oil. Fitting presents no difficulty. All components are manufactured to close tolerances and are therefore fully interchangeable.

The various arrangements of Muntz direct flow indicators are designed to operate at pressures up to 1,000 lb/in².

Circle **68** *for further details.*

Light-duty Electro-magnetic Counter

THIS new light-weight counter Type 1250 has been designed primarily for hot and cold drink dispensing vending machines, though many other applications exist.

It is a three figure model with manual preset which enables the counter to be set to a predetermined number and when pulsed subtracts to zero when a micro-switch either opens or closes a circuit.

The cut-out device is so arranged that the unit can be preset at any number between zero and 999.

Models are available for most standard voltages from 24 volts d.c. to 230 volts a.c. and care in the design has been taken to ensure that the unit is unaffected by humid conditions.

Delivery is approximately 12 weeks from receipt of order and the unit price is £4 10s. each.

Circle **69** *for further details.*

Precision Multirange Meter

THIS is a portable sub-standard indicating instrument for the calibration of industrial grade meters, laboratory and field use.

The standard models are calibrated at 50 c/s but instruments can be supplied for any frequency between 16 and 60 c/s.

As well as voltage and current measurements, the determination of apparent true and reactive power and therefore power factor is possible in networks subject to small mains fluctuations. This is done by numerically or graphically calculating the results obtained by three successive measurements, one of which is carried out with simultaneous current and voltage measurements. It has a dynamometer type of movement which is iron free and magnetically shielded.

For the current ranges a precision current transformer is incorporated.

The accuracy of this instrument is 0·2% at full scale on all ranges, and it has a knife edge pointer and mirror scale. The scale length is $5\frac{7}{8}$ in.

There are eleven current ranges: 5, 10, 20, 50, 100, 200 and 500 mA and 1, 2, 5 and 10 A. Eight voltage ranges are also incorporated as follows: 5, 10, 20, 50, 100, 200, 500 and 1,000 volts.

The instrument is contained in a mahogany case covered with a laminated plastic; it is provided with a carrying handle and lid which contains the instructions and test certificate.

The manufacturers are Messrs. Norma, of Vienna, and the instrument is available in the U.K. from Croydon Precision Instrument Co.

The delivered price is £150 0s. 0d.

Circle **70** *for further details.*

Pneumatic Time Delay Relay

SQUARE D LTD. announce the introduction of a new pneumatic time delay relay. The new relay, designated Class 9050 Type A, is reliable, compact and versatile and is an evolution from their now extensively used Class 8501 Type D relay.

The timing period is adjustable from 0·2 seconds to 1 minute with good repeat accuracy. Normal variations in voltages and temperatures have very little effect upon the time accuracy because of the principles upon which the timing action is based. A unique feature is the closed air circuit, this prohibits the ingress of foreign matter into the pneumatic system and thus ensures reliability.

Timers are available with time delay after energisation of magnet coil, or time delay after de-energisation of magnet coil. Either type of relay can be converted to the other without the use of additional parts.

A single pole, double throw timed contact is provided with pilot duty ratings up to 600 volts a.c. Coils are available in standard rating up to 600 volts a.c. in 50 or 60 cycles.

The relay has been designed so that all conversions and maintenance are quickly and easily effected from the front of the panel. Terminals are provided with pressure wire connectors and are also easily accessible from the front.

Circle **71** *for further details.*

Pulse Measuring Potentiometer

FOR the accurate measuring of high voltage pulses in radar transmitters and other pulse circuitry, Ferranti Ltd. have introduced the Type PD.30 pulse measuring potentiometer.

The potentiometer can either be built into an equipment to provide a permanent pulse voltage measuring facility, or can be supplied in a case as a portable test instrument for use in the laboratory. The PD.30 is likely to supersede the use of conventional oil filled condensers and externally shielded vacuum capacitors for the measurement of high voltage pulses. This small lightweight instrument consists of a high voltage vacuum capacitor internally shielded by a metal cylinder to eliminate the effects of external stray capacitances, and a lower element which is either a capacitor for high voltage division or a resistor for differentiation. The lower elements are protected by a Ferranti Type AD.42 cold cathode diode.

The PD.30 is designed for handling high voltage pulses up to 30,000 V and has four ranges provided by a selector switch giving two pre-set voltage division ratios and two differentiation ratios. Voltage division ratios are normally pre-set for ratios of 250:1 and 500:1 and differentiation ratios are pre-set for 7·5 kV/μs/V and 5 kV/μs/V. Input capacitance of the measuring oscilloscope has some effect on the calibration, and an allowance of 45 pF has been made. On the most sensitive 250:1 range a change of 8·5 pF produces approximately a 1% error. The top capacitance of the device is $3{\cdot}4 \pm 0{\cdot}2$ pF and the total load capacitance is 6 pF maximum.

The instrument is supplied complete with convenient connecting leads for both the high voltage and oscilloscope connections. Shunting effect of connecting cable capacitance on the resistive element is minimised by inserting the lead through plug/socket, which is provided, and has selected terminating resistors incorporated. The high voltage lead is fitted with a clip which enables the potentiometer to be connected easily across the high voltage pulse circuit being measured, i.e. across the magnetron pulse transformer.

The oscilloscope being used must have a high impedance input for all ranges.

Circle **72** *for further details.*

Rotawinder Air-operated Coil Winding Machine

THE ROTAWINDER is a new machine designed to wind a precise number of close wound turns of wire on to a former, for the high frequency field of radio and television. It has been developed by Work Study Equipments.

The machine consists of a floor standing frame, upon which are mounted the winding head and former indexing table. These two units are mechanically independent of each other, but are pneumatically interlocked, so that the table presents a new former to the winding head as soon as winding of the previous former is completed.

Motive power for the winding head is provided by a pneumo-hydraulic cylinder unit, which drives a train of gears via a rack, to impart rotary motion to a hollow mandrel, down which the wire passes, and from thence to the winding arm which describes a circular path about the axis of the stationary former mounted on the table. A non-return clutch is incorporated in the gear train to ensure that the winding arm only rotates on the down-stroke of the piston and releases itself on the up-stroke, so that the coil cannot be partially unwound. This factor and the positive stops which come into action at the end of each winding stroke ensures that completely wound coils are obtained every time and the wire is always in exactly the right position to be picked up by the next coil as the table indexes. The number of turns wound on to the former is controlled by the piston stroke which can be varied by moving the stop to give increments of one turn. The rate of winding is also variable by a throttle valve in the hydraulic circuit which controls the piston speed. This ensures that, on coils where only a few turns are required, there is sufficient time to bond the wire on to the former in the stage after winding, during the winding cycle.

Wire is fed to the winding arm via the hollow mandrel from a stationary bobbin and passes through an adjustable tension unit immediately prior to entry into the mandrel. This independent tension service obviates the usual difficulties experienced when braking is applied to a rotating bobbin and the varying torque effect produced as wire is removed. Corners, at which the wire changes direction, are shielded by glazed ceramic rings which, apart from reducing random friction effects to a minimum, ensure that the wire insulation is undamaged as it passes through.

The indexing table consists of a seven station jig for the formers which is pneumatically rotated in sequence with the winding head piston.

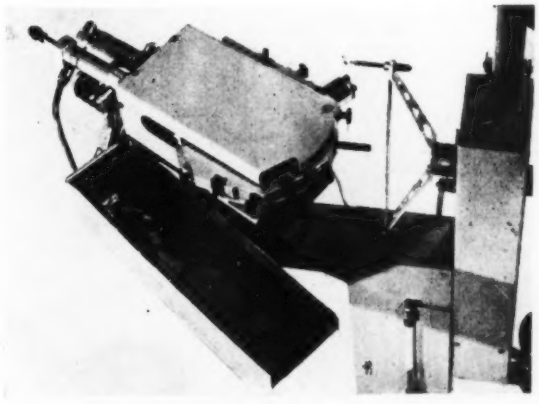
The primary loading station is located immediately in front of the operator who slips a former into the slots provided for the end check or, in the case of formers without checks, on to a peg. The second station can also be used for loading if due to a faulty former or other cause the operator is unable to load the primary station in the winding cycle which takes place at the third station. After winding the former indexes to the fourth station where it is heated to bond the wire to the former and then passes successively to the fifth and sixth positions where it is cooled prior to parting off and ejection at the seventh.

Each station is fitted with an adjustable wire guide which picks up the wire from the winding head and lays it over the former to be wound as the table rotates. Adjustment of these guides determines the position on the former at which winding commences, which, once locked, becomes invariable and exact duplication of results is ensured. The wire guide performs a dual function in that it acts as an anvil against which the wire is parted at the seventh station by means of a guillotine actuated by a small supplementary cylinder. This guillotine is interlocked with the indexing mechanism so that jamming is impossible.

Once the wire guides have been set to give the starting position required, repetitive accuracy is solely a function of the tolerance in the wire itself, e.g. a change in wire diameter will only affect the length of the coil and not the point at which it starts or the number of turns which is always an exact multiplication factor of unity.

The heater which bonds the wire in the fourth indexing position derives its current from a transformer which drops the voltage to 45 volts, thus lowering the danger factor due to a wire breaking and touching the element, to a safe figure from the operator point of view. After cooling in the fifth and sixth positions the wire is positively locked on to the former and is unable to unwind or spring and when ejected at the seventh position the coils have two free ends approximately two inches long for soldering to the former check tags in a subsequent operation.

By resetting the machine or passing to another, a further coil can be wound on the same former, thus making the ROTAWINDER universal for the production of either tuning or i.f. coils.



Air-operated coil winding machine

The machine is available in two forms mechanically similar but with differing pneumatic circuits.

Semi-automatic

This type is operated by depressing the pedal momentarily which then stays depressed until winding, which commences immediately, is completed. The winding piston operates a valve at the end of its stroke which returns the pedal and the piston ready for the next cycle which will not commence until the pedal is reoperated. If the pedal is held depressed winding will be completed but the winding piston will not return

and the table will not index until it is released. This enables the operator to perform any special requirement such as shellacing or taping if self-bonding wire is not used but slows down the cycle rate considerably.

Cycling

These machines are designed to automatically wind and index all the time the pedal is depressed. The sole requirement for the operator is the placing of formers in either No. 1 or 2 index position at the rate of winding which can be stopped at any time by releasing the pedal. For coils with few turns the winding cycle has to be slowed to give the necessary minimum of 4 seconds at station No. 4 for the coils to be bonded, thus a maximum of 900 coils per hour can be wound using this method.

Additional features which can be incorporated in the basic machines are as follows:

1. Provision for winding up to 125 turns
2. Provision for spaced winding
3. Automatic former loading
4. Automatic stop to prevent winding if former supply ceases.

Servicing

Routine maintenance has been cut down to an absolute minimum and apart from occasional replenishment of the hydraulic oil reservoir the machine is self-lubricating and requires no other attention. The oil reservoir is fitted with a sight glass to give ample warning when refilling is required.

The supply is compressed air at 80 lb/in² (other pressures to special order) and 240 volt 50 cycle a.c.

The consumption is 0·3 ft³ (free air)/min and 250 watts.

Capacity

Former size 0—1 inch, round, rectangular, polygon or square

Basic machine 1—30 turns in increments of 1 turn

Wire size 22 s.w.g. to 46 s.w.g.

Winding time, 30 turns—6 seconds, 20 turns to 1 turn —4 seconds.

Price

Semi-automatic machine £700.

Cycling machine £725.

Delivery: 8—10 weeks.

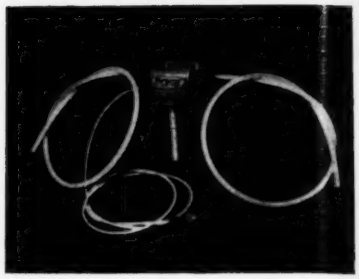
Circle **73** *for further details.*

Micro H Chemical Feeder

FP micro H chemical feeder is now offered in Britain by Fischer & Porter Ltd., who are assembling it in their Workington factory.

This chemical feeder is designed to feed, meter and regulate very low flow rates of a chemical solution continuously into a liquid stream through its built-in ejector. By virtue of its plastics construction the instrument can be used with a very wide range of corrosive fluids. The reagent flow rate is manually set and automatically regulated by an integral differential pressure regulator.

The price of the micro H chemical feeder is £33 8s. 6d. and is supplied with two 4 ft lengths of plastic tubing with adaptors for the supply and solution lines and a 6 ft length of plastic tubing fitted with a filter for the reagent suction line.



Micro H Chemical Feeder

Circle **74** *for further details.*

Silicon Epitaxial Transistors

EPITAXY, one of the most significant advances in the history of semiconductor technology, has led to the development of high speed silicon transistors and Texas Instruments announces the first commercially available units to be manufactured in the U.K. with their 2S131 Type.

Compared with conventional switching transistors of the mesa-type, in equivalent circuits the epitaxial 2S131 will switch approximately twice as fast at the 10 mA current level and four times as fast at 100 mA.

An epitaxial layer consists of a film of material deposited on to a parent single crystal substrate of the same material which, under suitably controlled conditions, takes up the same crystal form of the parent substrate.

In designing the 2S131 transistor, its characteristics have been optimised to give a fast switching device, with low saturation resistance, low capacitance, low hole storage, and a high F_t. Low saturation resistance has been achieved by the use of a low resistance substrate, which has the added advantage of yielding a device with a bottoming voltage largely independent of temperature over the range −65 to 175°C.

By special diffusion processes in the epitaxial layer very thin base regions are produced to give low hole storage and very high frequency characteristics and by the extension of mesa and photo-masking technologies devices of low collector capacitance, high collector breakdown voltage, low leakage currents and high reliability are made.

The 2S131 features an extremely low typical collector capacitance of 3·5 pF at 5 volts, a typical F_t of 300 Mc/s and typical switching characteristics in saturated circuitry are—turn on time 8 nano-seconds—turn off time 25 nano-seconds. These characteristics combined with the low and essentially temperature-independent saturation resistance of the device make it particularly suitable for application in current ranges 1 to 100 mA with a maximum allowable continuous collector current rating of 200 mA.

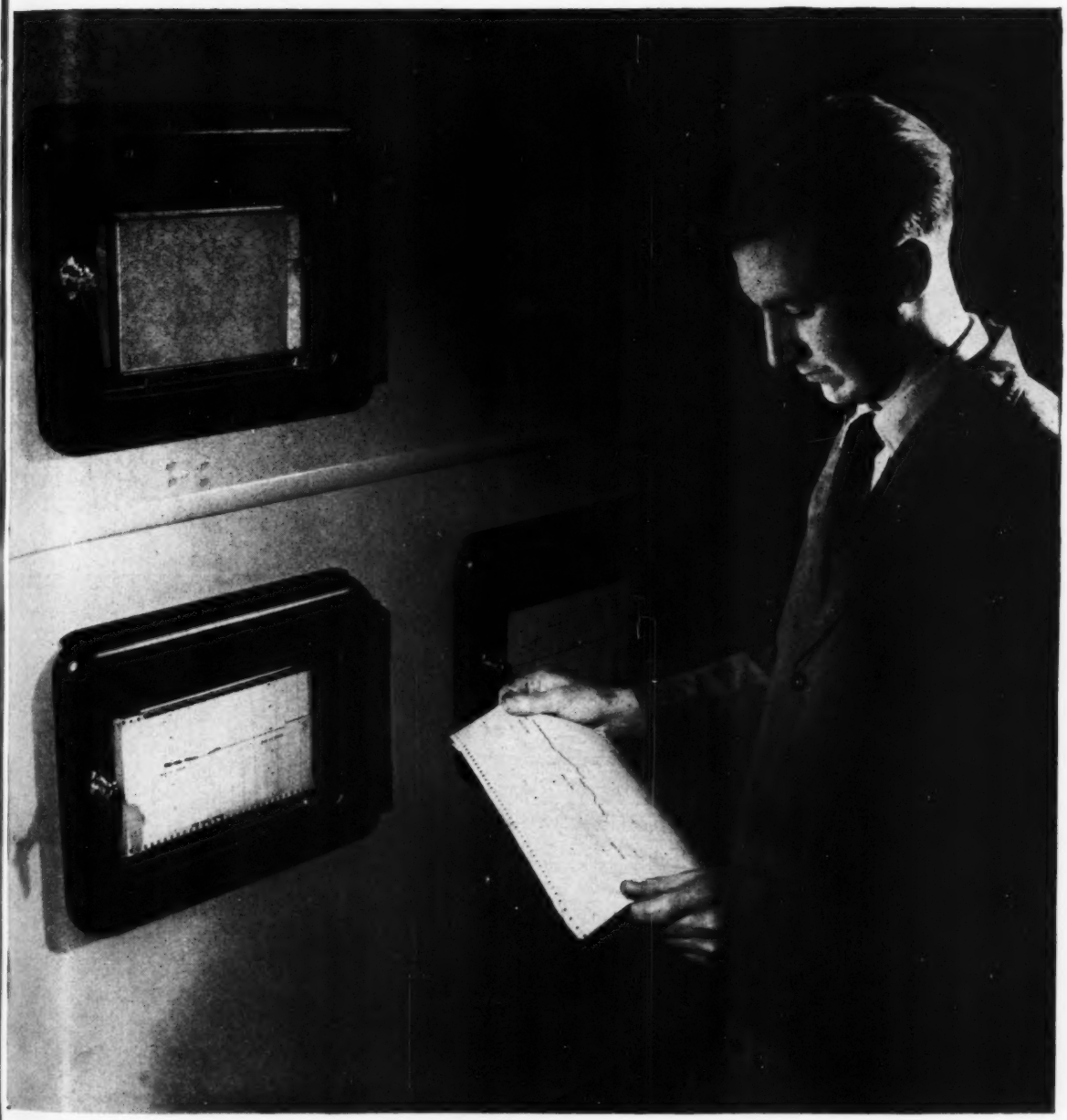
This new device is hermetically sealed in the To. 18 package and renders the transistor impervious to climatic conditions and contributes to its reliability and ruggedness.

Circle **75** *for further details.*

Circle **357** for further information

He reads it easily . . .

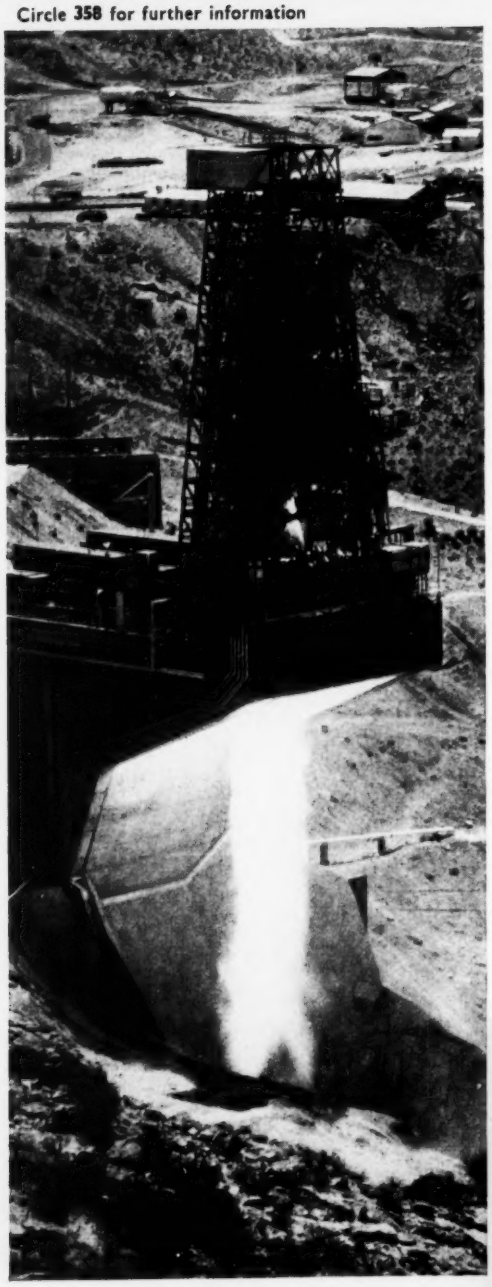
A clear record of the last two shifts—and the pen already beginning its course on the next chart. In his hand he has the past: on the panel is the present. Arkon Recorders measure gas, air, water and effluent flow, pressure or vacuum, or pressure and vacuum; flows in one inch pipe or 36 inch mains, pressures from 0.1 inches water gauge to 500 lb. per square inch. They give a clear, unmistakable record which you can read like a book, without hesitation and without mistakes. You can leave the chart on for a few hours, a day, or a week—the record will always be there. Easily read, easy to look after, robust enough to stand on the job, Arkon Instruments can help the control of any process—and their accuracy will satisfy even the men in the lab.



More about Arkon recorders in our illustrated leaflet

WALKER CROSWELLER & CO. LTD · CHELTENHAM · Tel: Cheltenham 56317

Circle 358 for further information



Official U.S. photograph

Off into space

Scientists and engineers at the Rocket Test Laboratory, California, working continuously with Thor, Atlas and secrecy-cloaked missiles of the future require instrumentation of unquestioned accuracy and dependability. To monitor thrust, flow, force and temperature parameters they are using more than

600 Speedomax Recorders

part of one of the most extensive data recording systems in the world.

Throughout more than eight years of operation Speedomax Recorders involved in data gathering have surpassed the exacting performance standards required.

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NEWS OF THE INDUSTRY

INSTRUMENTS

A NEW **light detecting device** which can aid in evaluating research data from an orbiting satellite is reported at IBM's Thomas J. Watson Research Centre. The device is the heart of a system that determines in which direction the satellites' instruments are pointed.

Called the " Moonlight Photodetector ", the device is ten times as sensitive as silicon solar cells and other similar semiconductor light detectors, and has a silicon surface smaller than a pinhead. It is sensitive enough to detect very weak light rays from the moon, yet rugged enough to withstand intense direct sunlight and firing of the satellite vehicle into space. The photodetector requires so little power that a 1·36-volt battery the size of a penny can operate it for several years.

The new light detector uses some of the electronic properties of a semiconductor electrolyte contact and consists of the semiconductor (silicon) and the liquid electrolyte (sulphuric acid). Because of its operating principle and construction, the detector provides extra light sensitivity in a compact light-weight package.

An additional property of this type of detector is an improved ability to detect ultra-violet radiation. Because of this property, a second detector with much greater surface area has also been developed by the IBM scientists. The second detector, which has a self-contained power source, is designed primarily to detect ultra-violet rays rather than visible light, and could also be used in satellites as well as in other applications.

In conventional photo diodes and solar cells considerable light is absorbed as the rays pass through a thin layer of semiconductor material to get to a junction where they are converted into electrical energy. This loss of light by absorption is significantly reduced in the new IBM device since the surface layer in this device is a transparent fluid.

The scientists report that many electrolytes could be used, but sulphuric acid was chosen because it exhibited a high degree of stability over a wide temperature range to comply with requirements of space satellites.

FOLLAND AIRCRAFT LTD., one of the Hawker Siddeley group of companies, is acquiring a **PACE 221R computer.**

This order follows close on that of Vickers Armstrongs (Aircraft) Ltd. who recently ordered a PACE 231R high accuracy computer primarily intended for the solution of problems associated with Britain's new TSR 2 aircraft.

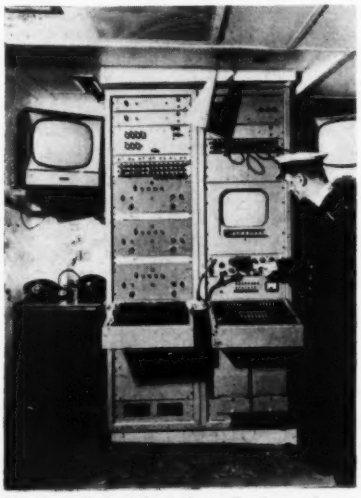
These two new PACE installations will be the first to be installed in Britain's aircraft industry and they illustrate the need for high accuracy analogue computation to deal with the complex problems associated with Britain's new line of aircraft.

THE Plessey Co. Ltd. has received Services' approval to DEF 5251 for its new range of B7G and B9A **saddle** and **skirted ceramic valveholders.**

The design of these valveholders, which are made at the company's Towcester Components Division, results from a straightforward development of the standard items already established in commercial use.

A particular feature of this new range is the ability to satisfy H.1 and H.2 humidity requirements of the relevant Services' specification.

Zone-refined (50 Ω-cm, n-type) germanium is now available from Johnson, Matthey normally in ingots having a nominal weight of 1 kg. A large scrap-recovery plant has been installed which enables a wide variety of types of germanium-bearing residue to be processed. The company now wishes to purchase large or small quantities of germanium scrap, and will be pleased to hear from any organisation having such material for disposal.



The P and O Orient liner Canberra has a television installation offering co-ordinated internal and off air service anywhere in the world.

To ensure speedy checking and the anticipation and location of any faults in the complex installation a rack mounted Tel-equipment Serviscope has been built into the television processing room.

HUGHES INTERNATIONAL (U.K.) LTD. announces that it has been granted type approval for CV7127. This is a **double-ended gold bonded diode** in the Hughes subminiature hermetically sealed glass package.

This diode has 70 volts minimum breakdown voltage, maximum reverse current of 25 μA at −50 volts with typical stored charge of 400 pico-coulombs.

TEXAS INSTRUMENTS is decreasing the prices of its entire line of **semiconductor devices.** These price reductions apply to all its diodes, rectifiers and transistors manufactured at Manton Lane, Bedford, and they are effective from 1st June.

Examples of prices cited are the Moly-G Diodes—the 1S111 from 17s. 0d. to 11s. 0d.: the 1S113 from 25s. 0d. to 16s. 0d.: the Top Hat Rectifiers—the 1S003 from 32s. 0d. to 25s. 4d.: the Stud Top Hat Rectifiers—the 1S402 from 42s. 0d. to 34s. 2d. In transistors, examples cited were the Small Signal Grown Junction—the 2S002 from 60s. 0d. to 55s. 0d.: the Silicon Diffused Medium Power—the 2S017 from 110s. 0d. to 91s. 8d.: the Silicon Alloy—2S301 from 16s. 0d. to 9s. 6d.: the Germanium Mesa Amplifier—2G101 from 25s. 0d. to 15s. 6d.

COMPANIES

Hilger & Watts Ltd. announce that **Wray (Optical Works) Ltd.** have come into association with them.

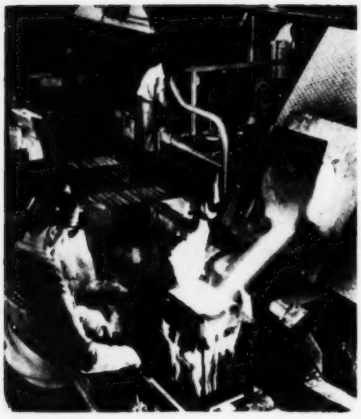
Mr. A. W. Smith (a former President of S.I.M.A.) is continuing as managing director of Wray (Optical Works) Ltd. Mr. Smith is currently Chairman of the S.I.M.A. Education Committee and of the City and Guilds Advisory Committee for Instrument Making.

THE **Severn Instrument Co.** has recently been established to provide:

1. A sales agency for control equipment in South Wales and South Western England
2. Complete control schemes
3. Manufacturing facilities for special purpose control valves to customers' specifications on a country wide basis.

Mr. K. H. Lloyd has been appointed manager of this organisation.

The company has been appointed agents in the above areas for Crosby Valve & Engineering Co. Ltd., to handle Crosby and Masoneilan products.



Permanent magnets being cast at the foundry of Preformations Ltd. The plant, which has an annual production capacity of several million magnets, manufactures units for every type of magnet application from loudspeakers to cyclotrons and radar isolators.

IBM have opened near New York the new Thomas J. Watson Research Centre on which work began in 1958. Housing some 1,500 scientists and other personnel, it becomes the largest centre in the world for the study of computer sciences.

Work at the new centre will be divided into six broad fields:

General Science—investigation into magnetics, low temperature and semiconductor phenomena. Last year scientists developed two new optical maser devices.

Solid State Science—this group has developed a method of vapour growth of computer components.

Experimental Systems—the study of new systems for the machine translation of languages, information retrieval and the control of chemical and other industrial processes.

Experimental Machines—the development of advanced concepts for extremely high-speed computers.

Engineering Science—research into voice and printed character recognition by machine.

Mathematical Sciences—investigation into new logical approaches to computer design and computer problems.

THE Teddington group of companies has formed a new company at Sunbury-on-Thames, **Teddington Controls (Export) Ltd.,** to expand and develop the overseas sales of the products of Teddington Refrigeration Controls Ltd., Teddington Industrial Equipment Ltd. and Teddington Autocontrols Ltd.

The managing director is Mr. E. Burman, who has been associated with the Teddington group of companies for nearly 30 years.

The sales manager of the new company is Mr. L. E. Bayliss, who for the past 18 months has been working closely with Mr. Burman in developing the group's export sales.

THE Attwood group of companies has formed a new British company, **Attwood Technical Services Ltd.,** to undertake economic research throughout the world.

Attwood Technical Services Ltd. and ERC International Incorporated have made an agreement covering the carrying out of economic research in Canada and the United States. The agreement also provides that Attwood Technical Services will carry out economic research in the United Kingdom for ERC International.

Attwood Technical Services Ltd. will include among its activities detailed studies of economic and market conditions in Britain and overseas on which manufacturing and commercial companies will be able to base their future plans and development. The research, which will be carried out for British and foreign companies alike, will be of a specialised nature directed to their particular requirements. It will include the gathering, collating and analysing of information bearing upon clients' decisions on policy in both their home and overseas operations.

The new company will also act as foreign trade consultants on matters such as representation, manufacturing facilities and licensing agreements.

Friden Ltd. has been formed as a subsidiary of Friden International S.A., Fribourg, Switzerland, which is the international marketing company for Friden Incorporated, San Leandro, California, and Friden Holland N.V.

Friden Ltd. has commenced operations in the United Kingdom from 1st June, 1961, to distribute the range of Friden products, formerly handled by Bulmer's (Calculators) Ltd. Friden office automation equipment includes the Friden calculating machine, Flexowriter, Justowriter, Collectadata, Selectadata and other data processing equipment.

Further new products, concurrent with Friden's expansion programme, will be released on this market in due course.

The head office of the company is temporarily housed at 4 Great Winchester Street, London, E.C.2. Tel.: LONdon Wall 3761/4.

"COMPUTER ACHIEVEMENTS" is a new 22-minute film in colour and sound, produced by **EMI Electronics Ltd.** It features five of the many varied uses for which EMIDEC computers are being supplied to leading industrial organisations and the Army:

Boots Pure Drug Company, on a system of merchandise accounting; British Motor Corporation, for payroll and sales accounting; British European Airways, to solve its problems of inter-airline transfers and revenue accounting; Barclays Bank, to handle all the current accounting for over a dozen West End branches; and the Royal Army Ordnance Corps, accounting for the Army's motor transport spares.

MR. B. R. LAW, chairman of **International Computers and Tabulators (New Zealand) Ltd.,** is now visiting the parent company in the U.K. to confer on developments and the expansion of I.C.T.'s 40 column equipment sales in New Zealand.

A major topic of interest is the new factory building of 10,000 square feet situated close to Wellington's new airport. This building, which will house card works, stores, workshops and an engineering training school, will soon be ready for occupation.

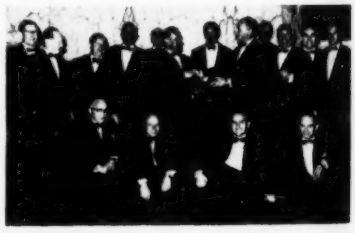
Considerable interest is being shown in New Zealand in British electronic data processing equipment. An order has recently been placed by a government department for an I.C.T. 1200 Series computer which is to be followed later by one for the larger and more advanced Type 1301 model.

International Computers and Tabulators Ltd. has taken over the premises of Glover and Main Ltd. with their frontage on Thornton Road, Croydon. Thus 100,000 square feet of manufacturing space have been added to the 290,000 square feet of I.C.T.'s Croydon factory.

The new production site will be devoted initially to the assembly of I.C.T.'s 900 Series tabulators.

THE Drayton Regulator & Instrument Co. Ltd. announce that, as from 1st June, the name of the company will be changed to **Drayton Controls Ltd.**

The telephone number remains as before, viz. West Drayton 4012, but the telegraphic address is altered to Draycon West Drayton Telex.



Three hundred guests and staff attended a dinner and dance at the Metropole Hotel, Brighton recently, to celebrate the 25th anniversary of the formation of the founder member of the group, Bowthorpe Electric Co. Ltd. The photograph shows the directors of the companies within the group and Mr. R. A. Parsons (left) managing director of Hellerman Ltd. presenting a silver rose bowl to Mr. Bowthorpe to mark the occasion.

Associated Electrical Industries have closed their service depot for Ediswan Mazda cathode ray tubes at 92 Oxford Road, All Saints, Manchester, 13, from 2nd June, 1961. Service to dealers in the North-West area will be maintained from the AEI CRT service depot at 53 Trafalgar Street, Sheffield, 1, under the supervision of Mr. D. A. Ward. Telephone number: Sheffield 27004.

THE **Record Electrical Co. Ltd.** are celebrating their golden jubilee this year. The company was started in 1911 by John Westmorland Record for the purpose of manufacturing high quality electrical measuring instruments, and the company, though greatly enlarged now, still has the same aims. In 1955 it was agreed that a merger between Record Electrical and Evershed & Vignoles would prove mutu-

ally beneficial and the senior company assumed financial control; apart from an interchange of directors both companies have continued to function as separate entities.

Foxboro-Yoxall's Redhill factory is being expanded. A packing material store has been built facing the packing department in the main factory and is now in service. A new wing of two storeys has been added to the administrative block and factory production is being doubled in size by the addition of an 85,000 sq ft extension. A separate building will also be erected to provide enlarged workshops and stores for the maintenance unit.

THE **Plessey Co. Ltd.'s** plans to extend two of its Towcester plants have now reached an advanced stage.

In the Water Lane factory more space will be devoted to the production of matrices for complete memory systems and other data processing applications. At the moment, this factory produces a wide range of " Ferramic " memory cores as wound core assemblies, as single matrix planes in standard or special forms, and as matrix stacks to customer requirements. Other ferrite materials are produced as square loops for fast switching functions, as low drive cores for coincident current applications and as " Ferramic " linear ferrites for pulse transformers and magnetic reading heads.

At the Wood Burcote Way factory a new canteen is to be built which will cater for the growing number of Plessey Chemical and Metallurgical Division employees in Towcester.

IN order to meet the increasing demand for their FM range of electricity meters, **Ferranti Ltd.** have recently embarked on a £200,000 modernisation and reorganisation scheme of their meter department at Hollinwood, Lancs., which is expected to increase production capacity by about 30%.

The scheme, which will be carried out in three main phases, is due for completion by the end of this year. The first phase, the reorganisation of the meter plating shop, is already in progress and advanced techniques are being applied to its layout. The second phase, which has also commenced, covers the installation of a wide range of new equipment and the improvement of plant layouts in other sections of the Department.

Later this year it is expected that the final phase will be completed with the installation of a new £84,000, 33-station, automatic inline linked transfer platen machine—manufactured by James Archdale & Co. Ltd., of Worcester. This will be used for carrying out machining operations on the cast iron frame of the Ferranti FM single-phase kWh meter; it replaces a semi-automatic machine arrangement. In this new transfer line, once the meter frame is clamped in the platen fixture—the line accommodates 65 platen fixtures—it will be passed through the entire sequence of maching operations without removal from the jigs, thus giving greater accuracy in machining.

Bribond Printed Circuits Ltd. has taken over one of the Ayling Industries group's factories which is situated on the industrial estate at Chichester for the manufacture of printed circuits. This factory was formerly occupied by Hambling Industries Ltd., another company within the group.

Bribond Printed Circuits Ltd. was formed recently to take over the Printed Circuit Division of Bribond Ltd., another group company, whose factories are at Burgess Hill and Portslade.

Ultra Electric (Holdings) Ltd. have sold their domestic radio and television interests to Thorn Electrical Industries Ltd. for £2·4 million.

Ultra Electronics Ltd. have acquired Trix Electronics Ltd., which since incorporation on 1st May, 1961, has been a subsidiary of the Trix Electrical Co. Ltd.

Trix Electronics will continue to manufacture and install sound amplification equipment for public address and aircraft work.

Coulter Electronics Ltd. have moved to 2-4 Ashwell Street, St. Albans, Herts (St. Albans 50828) where larger factory, laboratory and office space is available. The company expects to have a new model of their particle size distribution counter available shortly.

Electronic Switchgear (London) Ltd. have now completed their move to new premises, comprising both factory and office accommodation, of modern design, at Wilbury Way, Hitchin, Herts. (Tel.: Hitchin 3646.)

The increased capacity, which now becomes available as a result of this move, will permit considerable expansion of the company's range of industrial control equipment on a wide basis.

THE Middlesbrough Branch of **Honeywell Controls Ltd.** has moved from Fletcher Street to new premises at 59/60 Albert Road. Telephone number is unchanged, Middlesbrough 4.43.31 and 4.43.32.

The branch will continue to handle sales and service of industrial process controls and instrumentation, data processing equipment, automatic temperature and air conditioning controls, and other Honeywell equipment.

Mallory Batteries Ltd. have moved to a new factory on a five acre site at Crawley.

AGREEMENTS

Ultra Electric (Holdings) Ltd. recently announced an agreement between Ultra Electronics Ltd. and an American company, **Electronics Investment Management Corporation,** for the complete interchange of information on research, development, marketing and production of electronic equipment. At the same time 40% of Ultra Electronics Ltd. was sold to Electronics International Capital Ltd., the first international capital banking institution to concentrate its investments in electronic companies in the free world. At that time the chairman forecast considerable expansion of Ultra Electronics Ltd. in all electronic fields.

West Instrument Ltd. have just concluded agreements whereby they will act as agents in this country for two U.S. companies.

The American companies are **Radiation Electronics Corporation,** a division of the Comptometer Corporation and manufacturers of radiation thermometers and infra-red scanning systems, and the **RdF Corporation,** which makes resistance thermometers and allied equipment.

In the case of the radiation thermometers and certain types of resistance thermometers, it is stated that no similar equipment is being manufactured in Britain.

Continental Connectors Ltd. are sole selling agents for the products of the Components Division of **Miles Electronics Ltd.**

At the moment the main products concerned are precision potentiometers.

A RECIPROCAL sales and manufacturing arrangement has been established between the **Wayne Kerr Laboratories Ltd.** and **Gertsch Products Incorporated,** of Los Angeles, U.S.A.

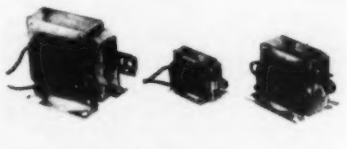
The agreement provides for the marketing and manufacturing of a wide range of Gertsch electronic instruments in the U.K. solely by Wayne Kerr and for the sale of Wayne Kerr instruments by Gertsch Products in California, Nevada and Arizona.

Principal Wayne Kerr instruments covered by the agreement include the Wayne Kerr transfer function computer SA100, transformer ratio arm bridges, r.f. and v.h.f. bridges and vibration and distance measuring equipment.

Some of the Gertsch instruments which will now be marketed by Wayne Kerr include precision ratio transformers, frequency measuring equipment, synchro and resolver standards and special test instruments.

AN agreement has been signed between **Westool Ltd.** and the **Controls Company of America,** Illinois, whereby the British company is to manufacture exclusively under licence in the United Kingdom the SORENG range of solenoids which are produced in the U.S.A. by the Controls Co. and distributed throughout the world.

The SORENG range of solenoids is very extensive and typical applications in the U.S.A. include home laundry equipment, refrigerators, motor cars, aircraft and vending machines.



Examples of the Soreng range of solenoids

As a result of a sales agreement with the **American Meter Co. Inc.,** Philadelphia, U.S.A., **Parkinson Cowan Gas Meters** are now marketing in Great Britain the American company's volume and pressure gauges and base pressure and volume indexes.

All the equipment covered by the agreement is for use with the new type of high pressure meter recently introduced to this country by Parkinson Cowan and also with the Connersville-type meters distributed by W. C. Holmes and Co. Ltd.

THE French company, **Société Anonyme des Etablissements Ed. Jaeger,** of Paris, have accepted an invitation to become sole representatives in Metropolitan France for **Smiths Aircraft Instruments Ltd.** An agreement recently concluded between the two companies covers the sales and service of the complete range of aviation instruments and equipment, including the products of Smiths' associates, Kelvin & Hughes (Aviation) Ltd., and Waymouth Gauges & Instruments Ltd. The only items excluded are spark plugs, igniters and jet pipe temperature measuring equipment which will continue to be handled in France by Smiths' associate there, K.L.G. Société Anonyme.

Among the more important items covered by the Jaeger agreement are autopilots, including automatic landing equipment, flight systems, para-visual directors, manometric and engine instruments, synchros and small motors from the very extensive components range, air data computers, and fuel contents gauging systems.

The full address of Jaeger is: 2 Rue Baudin, Levallois-Ferret, Seine, France.

UNDER an agreement concluded with the **Filtron Co. Inc.,** of America, **Belling & Lee Ltd.** are making a range of interference suppression filters pioneered and internationally sponsored by that company. They will be known as " Belling-Lee Filtron " filters. These filters are hermetically sealed, and suitable for operation in the temperature range—55 to +85°C (some types up to +125°C). They are made in ratings from 0·15 amp up to 300 amp, and up to 18,000 volts d.c. working.

AN agreement has been signed between **Solartron Laboratory Instruments Ltd.** (a member of the Firth Cleveland Group) and **Packard Bell Electronics Corporation,** granting Packard Bell a licence to manufacture the Solartron CD. 1014 portable double beam oscilloscope and the CD.1016, the rack mounted version of this instrument, in the United States of America.

Packard Bell have placed an initial order for 200 Solartron manufactured CD.1014 oscilloscopes to meet immediate sales needs whilst they develop full scale production to meet a forecast of 6,000 CD.1014 instruments per year. The agreement not only covers the full manufacturing know-how but also includes a visit by Mr. T. Daly, production director, Solartron Laboratory Instruments Ltd., who will pass on the benefit of his practical experience in such manufacture. Packard Bell contemplate full scale production of the CD.1014 will be achieved by October, 1961; manufacture of the CD.1016 will commence January, 1962. Packard Bell will then market these instruments in North, South and Central America.

Mr. J. Walker (left) and Mr. E. R. Ponsford (right) concluding the agreement between Packard Bell and Solartron

AGENTS

Matchless Machines Ltd. (Tesa Division) have appointed the following area distributors for TESA high precision measuring equipment:

Stuarts & Houston, 5 York Street, Glasgow, C.2, for the whole of Scotland.

Batesons Ltd., 105-111 Yorkshire Street, Rochdale, for Rochdale and surrounding area.

Cawkell Research & Electronics Ltd., of Scotts Road, Southall, Middlesex, a member of the Simms Group of Companies, have appointed Messrs. Hird-Brown Ltd., 244 Marsland Road, Sale, Cheshire, as their official agents for the counties of Cheshire, Yorkshire, Durham, Lancashire, Westmorland, Cumberland, Northumberland and North Wales.

This agency complements the company's Scottish and Midlands agency arrangements which are in the hands, respectively, of Elesco Electronics Ltd., 2 Fitzroy Place, Glasgow, C.3, and Hawnt & Co. Ltd., 112-114 Pritchett Street, Birmingham, 6.

Messrs. Hird-Brown Ltd., like their colleagues, will handle Cawkell's electronic measuring equipment, including the Remscope, but not their non-destructive testing equipment.

PRESSURE gauges, thermometers and special control instruments manufactured in Holland are now being marketed in the United Kingdom. **Cockburns Ltd.,** Cardonald, Glasgow, are to act as British selling agents for the E.N.F.M. Co., of Schiedam, Holland.

Special E.N.F.M. instruments to be marketed by Cockburns are automatic sampling units, and a temperature indicating controller for oil tankage. The sampling units can be adjusted for size and frequency of sample, and can be fitted with special intervals for operation with corrosive fluids.

As a result of a visit to Japan in November, 1960, by Mr. Denis Hendry, the **Kyokuto Boeki Kaisha** organisation of Tokyo have been appointed exclusive agents for **Solartron Electronic Group** products in Japan.

The range of equipment covers oscilloscopes, digital voltmeters and associated equipments, together with analogue computers, data loggers, process response analysers and other systems equipment.

By agreement with the Japanese agents, one of their engineers, Mr. Yukio Anzai, has come to Solartron for three months' intensive course in the various technical departments throughout the organisation.

EXPORTS

THE Société Genevoise D'Instruments De Physique, of Switzerland, has placed an order worth approximately £20,000 with **EMI Electronics Ltd.** for six EMI rotary control systems to fit " Rotoptic " rotary positioning tables.

This order from Geneva follows exhaustive testing on two prototypes of the EMI equipment.

ELECTRICAL equipment valued at nearly £250,000 for driving four 3,000 ft/min, 165-in. wide tissue machines and their associated winders, to be installed in Russia, has been ordered from the Motor and Control Gear Division of **Associated Electrical Industries Ltd.** by the Walmsley Group. The equipment is for delivery in Russia during 1962 and 1963.

The drives incorporate AEI electronic control. Each section of the machine is driven by a d.c. motor supplied from its own generator. The generator field is supplied from the magnetic amplifier output stage of a transistorised regulator which constantly compares motor speeds with a highly stable reference voltage. By means of the electronic control the speeds of adjacent sections are held to an accuracy of within ±0·1% and the overall machine speed to within ±0·2% of top speed despite changes of load, ambient temperature or supply system variation.

AN order for more than 600 remote indication and control equipment systems for Russia has been received by **Newman Electronics**—Division of Newman Industries Ltd.

This order is worth £10,000.

Delivery of the systems will start immediately and be spread over the next twelve months.

The Newman R.I.C.E. system is designed to provide remote indication and control of a wide range of units. In the Russian application the system will be used in conjunction with hydraulic valves.

AT **Belling & Lee's** annual export dinner at the Grosvenor House, Park Lane, London, eight different countries were represented by senior members of the firm's overseas agents; in many cases these were the heads of their respective organisations. Last year Belling-Lee showed a 35·5% increase in exports, having done rather better than the average for the industry.

W. & T. Avery, Ltd., of Birmingham, have recently obtained an order worth over $115,000 from the National Harbours Board of Canada. It is for three automatic grain weighers which will be by far the largest purely gravity operated machines of this type ever made. They are to have a capacity of 20,000 lb for each weighing and each scale will be able to handle up to 40,000 bushels an hour.

The machines are not finally due for erection until July, 1962, but already plans are being made at Soho Foundry for alterations to accommodate these giant scales. First on the list are modifications and enlargements to Avery's own grain elevator with which all machines are rigorously tested before dispatch.

An order has been placed with Smiths Aircraft Instruments Ltd. for forty-five **Kelvin Hughes 50,000 ft altimeters** to be installed in those aircraft of the Soviet Aeroflot which operate on routes through and into Western European countries. They will be fitted in addition to the present Russian altimeters.

International Computers and Tabulators Ltd. have recently received from South Africa orders for six of their new magnetic tape computers, the I.C.T. Type 1301. The total value of the orders is £600,000. Sixteen smaller I.C.T. computers have already been supplied to South African users.

The South African Railways have ordered three of the new computers; the other orders, all for single machines, are from the Johannesburg City Council, the oil company Caltex (Africa) Ltd., and the steel tube manufacturers, Stewarts and Lloyds of South Africa Ltd.

These computers will be installed and serviced by I.C.T. South Africa (Proprietary) Ltd., one of the 15 operating subsidiaries of International Computers and Tabulators Ltd.

Messrs. Alan Muntz & Co. Ltd. have appointed M. Falk & Co. Ltd. to handle the export management and sole distributorship for all countries outside the United Kingdom (with the exception of France) of their **oil flow indicator.**

The Muntz oil flow indicator, originally developed in the Feltham Research Laboratories of the company for use on the lubricating system of their free piston engines (Pescara/SEP/Muntz Patents), will now be available to all users and manufacturers of diesel engines, turbines and other equipment requiring controlled lubrication.

These flow indicators are also suitable for the control of flow of other liquids and of air or gases.

CONTRACTS

Equipment to link existing and new instrumentation in their Aerodynamics Laboratory to a Ferranti Pegasus computer has been ordered by Parsons and Marine Engineering Turbine Research and Development Association (Pametrada) from **Honeywell Controls Ltd.**

The order will be delivered at the end of this year.

By means of disc encoders and programming units, the temperature, pressure and other instrumentation will be adapted to punched tape output, which is fed to the computer.

Stringent self-checking will be incorporated. Tape will be prepared from a preset number of strip chart recorder readings; from recorders stepping in synchronism with a pressure scanning valve; from readings of a Dobbie-McInnes digital manometer; and from information manually set by keys.

Output from the disc encoders, manometer and keys is read simultaneously and fed to a group of memories, the output of these being scanned and converted to serial form for tape.

Penny & Giles have recently received a Ministry contract for the supply of accident data recorders.

The recorders are for use in aircraft for the purpose of recording data such that, in the event of an accident, the information recorded could be used to assist in determining the cause of the accident.

The system in prototype and preproduction form has been in certain aircraft since July, 1960, and the type of information being recorded comprises:

Indicated airspeed
Altitude
Control surface movement
Vertical and lateral acceleration
Aircraft heading
Fire warning, oil pressure warning, etc.
Speech can be recorded as an alternative.

In all, the existing system offers facilities for recording 24 channels.

In addition to manufacturing the recorders Penny & Giles also manufacture all the transducers required to measure the various parameters.

Brookhirst Igranic has received orders from John Lysaght & Company and A.B. Svenska Flakfabriken for the supply of motor control centres for the new Ford Motor Co. works at Halewood, Lancashire.

The orders are valued at £132,000.

Cabling of motor, control and distribution circuits from the individual starters will be carried out by Malcolm & Allan.

London University has ordered a Type 1301 electronic computer from **International Computers and Tabulators Ltd.** for use in the pre- and post-examination processes associated with the G.C.E. at both "O" and "A" levels.

For the past three years the University has been using I.C.T. standard punched card equipment for this work, during which time the number of candidates sitting the examination has been steadily increasing. The number is expected to rise to some 170,000 in the summer of 1962, involving the marking and evaluation of some 800,000 papers.

To meet this increasingly large commitment the University examination authorities have decided to introduce the faster and more progressive methods of data processing available through the use of a modern high speed electronic computer. By these means, the vast administrative load associated with preparing for the examinations will be eased, and the processing of candidates' marks will be speeded up to provide early publication of results and issue of certificates to successful candidates.

B.P. have awarded a contract to **Foster Wheeler Ltd.** for the design, engineering, supply and construction of the process units required for the lubricating oil project at their Kwinana refinery.

The process units to be supplied for the project are as follows:

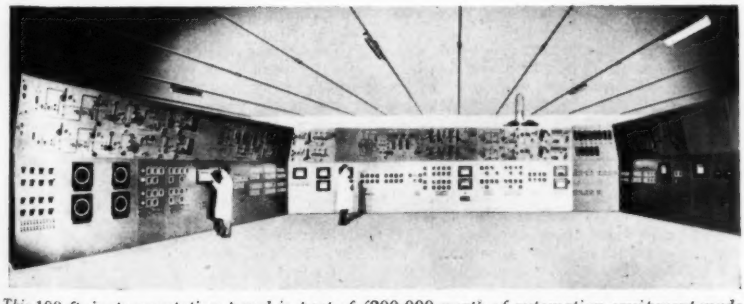
Vacuum distillation unit
Furfural extraction unit
M.E.K.—toluene dewaxing unit
Ferrofining (hydrofinishing) unit.

In order to utilise an established organisation in Australia for the construction of this work, Foster Wheeler Ltd. have formed an association with **Constructors John Brown Australia (Pty.) Ltd.** for this contract.

The new plant is expected to go on stream at the end of 1962, with an annual capacity of 100,000 tons of high grade lubricants.

A £40,000 contract for the supply of materials for and erection of a 132 kilovolt grid link in Lincolnshire has been awarded to **Associated Electrical Industries Ltd.** The work will be carried out for the Central Electricity Generating Board, North Eastern Region, by AEI Construction (Cables and Lines) Division.

The London Trustee Savings Bank has just placed an order with **I.C.T.** for punched card data processing equipment, including an I.C.T. Type 555 plugged



This 100 ft instrumentation panel is part of £200,000 worth of automation equipment made at the Newhouse, Lanarkshire, works of Honeywell Controls Ltd. by Vickers-Armstrongs, for a Russian chemical works. There will be nearly 200 closed loops for controlling temperature, pressure, flow, liquid level and other quantities. It will be installed by Honeywell engineers.

programme computer and one of the new 900 series tabulators. The bank plan to extend this new policy of mechanisation by the later introduction of an I.C.T. Type 1301 electronic computer. The decision to make use of this automatic data processing equipment was prompted by the need to install machine aid to handle more rapidly the ever-increasing volume of business, and to give even better service to the Bank's depositors.

BOOTS PURE DRUG CO. LTD. have placed an order for a **De La Rue Bull 300 D.P. Series data processing system,** to be installed in November this year.

The installation will be the first of its kind in this country and is of a capital value of over £40,000. Considerable expansion is foreseen, and in the initial stages the system will produce chemical manufacturing cost information for management.

THE **Solartron Electronic Group Ltd.** have a contract from the Ministry of Aviation to supply digital computing and data handling equipment to the Royal Aircraft Establishment at Aberporth for the high speed processing of digital radar information.

The equipment, in effect, creates a radar picture so that the target (missile) is observed, during its approach to its destination, at all stages of progress, during which time the "control brain" causes all other associated equipment to follow the target (missile).

All settings and changes are automatically recorded during a trial for later examination, and punched paper tape input facilities are provided for checking purposes.

A feature of the computing equipment, which basically consists of 6 Solartron Minimal computers, is the extremely high rate of computation, the requirement being for 2 polar/cartesian conversions, 14 parallax corrections, and 4 cartesian/polar conversions; all to 1 part in 10^6 accuracy, performed every 50 milliseconds.

The equipment is scheduled for installation towards the end of 1961.

SERVICES

A NEW delivery system on small orders for custom-built rotary switches has been set up in the **Havant Components Division** of The Plessey Co. Ltd., at New Lane, Havant.

Known as the "Blue Arrow" service, the new arrangement offers a seven-day delivery promise on any quantity of switches up to 50. This new service has been introduced to assist development engineers in obtaining, as quickly as possible, factory-made rotary switches to meet individual switching requirements.

Although primarily intended to help engineers in need of type-approved switches for Services and other high-quality electronic equipment, the new Blue Arrow service is also available to the domestic radio and television industry to provide suitable quality, special order switches in small quantities with the minimum delay.

Orders for switches are preferably given on the standard switch order formats. To facilitate the ordering of Plessey switches, the company will shortly have available a redesigned ordering format for use with GA 2 size 2 and size 3 rotary switches in accordance with the requirements of DEF 5154.

To supplement the Blue Arrow service, the range of Plessey switch kits is being extended to enable switches to be built with a wide variety of contact finishes and materials. The Blue Arrow service also provides a quick delivery on spare parts to replenish these kits.

The service has been operating on a pilot scale for the last few weeks and demand for switches made under the scheme has been increasing steadily.

C-E-I-R (U.K.) Ltd. have opened a computer centre at 58 Newman St., London, W.1. Computer facilities will be provided by IBM 7090 and 1401 data processing systems. Computer facilities may be obtained on a by-the-hour basis or working with C-E-I-R's programmers.

AN **analogue computation centre** to serve industries in the United Kingdom has been established near London by Electronic Associates, Ltd., wholly owned subsidiary of Electronic Associates, Inc.

The new facility, known as the United Kingdom Computation Centre, is located at the Burgess Hill manufacturing plant of Electronic Associates, Ltd., and is available on a time-rental basis for design and simulation programmes in nuclear, automotive, missile, chemical and shipbuilding fields.

Equipment at the new centre includes a 231R PACE system of 80 operational amplifiers and detachable pre-patching panels; a TR-10 transistorised desk-top computer of 20 operational amplifiers, and various recording systems.

THE **IBM Data Centre,** opening at 58 Newman Street, will be equipped with IBM 7090 and 1401 data processing systems.

At the Data Centre, IBM will maintain this equipment for the use of commercial and scientific organisations which wish to write their own computer programmes and operate the machines themselves. This differs from the service offered at the company's Service Bureaux where programming and operating staff are provided by IBM.

Although, at the Data Centre, the customer accepts full responsibility for operations, IBM will provide maintenance staff and also specialists who, without any additional charge, will be available to advise customer programmers and operators on the most effective use of the equipment. They will also give programming courses.

The method of operation at the Data Centre will have three advantages. It cuts the cost of using the equipment to the minimum; the customer keeps full control of the job; and the experience gained is valuable if that organisation later decides to install its own equipment.

Users of the IBM Service Bureaux also have access to a computer of the capacity of the 7090 for the first time, since the Service Bureaux can also draw on Data Centre facilities.

Clients of the Data Centre will have access to the SHARE library of IBM computer users, the largest collection of computer programmes in existence in the world. It is expected that the centre will be used, not only by large commercial companies and organisations engaged on large scale research, but also by a wide range of medium and smaller organisations that have no such computer facilities for their work.

ASSOCIATIONS

THE theme of the 13th **British Electrical Power Convention** held in Eastbourne from 12th to 15th June was "Electricity in the Prosperity and Welfare of the Nation".

The following papers were presented:

"The British Electricity Transmission System" by Sir Christopher Hinton, K.B.E., F.R.S. (Chairman, Central Electricity Generating Board).

"Some Aspects of Efficiency and Economy in Distribution" by B. A. Brown, B.A., B.Sc. (Chairman, Southern Electricity Board).

"The Electrical Power Industry in Canada" by Dr. A. E. Grauer, B.A., Ph.D., Ll.D., (Chairman, British Columbia Electric Co. Ltd., Vancouver).

"British Electrical Manufacture in the National Economy" by S. F. Steward, C.B.E., M.I.Prod.E. (Director, BEAMA).

SINCE the establishment of a **Machine Tool Industry Research Association,** earlier this year, considerable progress has been made. The Machine Tool Industry Research Association is now a grant-aided Research Association and headquarters are being set up in Manchester.

Information about the activities and future plans of the Association have recently been sent to members in the first issue of the M.T.I.R.A. News Letter.

The Joint Radio Committee of the Nationalised Fuel and Power Industries has prepared a basic specification for electronic telecontrol equipment which sets out the common requirements. In this way it is hoped to rationalise the production of suitable equipment and avoid the necessity to design equipments on an individual basis for specific applications.

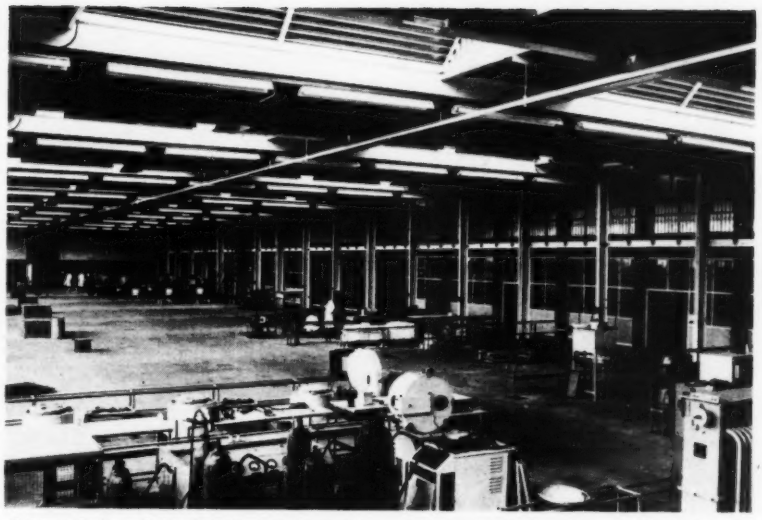
The specification provides information on the minimum facilities required and guidance on the techniques preferred, e.g. the use of items such as cold cathode tubes, transistors, magnetic cores, etc., rather than electro-magnetic relays and hot cathode valves, but it intentionally avoids laying down rigidly the exact manner in which any facility should be provided.

The equipment is intended to provide a highly flexible and readily extensible telecontrol system capable of keeping pace with the rapid growth of electricity and gas distribution; as such it would no doubt be of use to other large distribution systems. A number of outstations can indicate to a central station the state of

their plant by means of two-state and analogue measurements which are digitised for transmission; control of the plant from the central station is catered for but may be omitted if desired. Automatic alarm features are included and the central station equipment is arranged to give print-out for data logging if required.

The Joint Radio Committee has encouraged the development of this equipment and several manufacturers have shown an interest in meeting the requirements of the Fuel and Power Industries. The Plessey Co. and Pye Telecommunications Ltd. have already successfully demonstrated equipments specifically designed to meet the requirements of the basic specification.

Copies of the basic specification may be obtained from Mr. G. D. Turton, Secretary, Joint Radio Committee of the Nationalised Fuel and Power Industries, c/o Central Electricity Generating Board, Bankside House, Sumner Street, S.E.1.



A general view of the interior of the medium scale research laboratory of Pilkington Brothers' new £2,000,000 glass research centre at Lathom, near St. Helens

RESEARCH

A NEW research programme to improve the **manufacture of paper through the use of computer control** is being conducted at the new Thomas J. Watson Research Centre near New York which was opened by IBM recently. A number of paper companies and manufacturers of paper machines are co-operating with IBM scientists in work which is aimed at controlling an experimental Fourdrinier paper machine (recently installed) to produce uniformly high quality paper.

IBM is concerned in this project as a large customer of the paper industry, purchasing well over 100,000 tons of card stock each year. Paper is the most economical material for punched cards, but certain physical properties of paper sometimes cause problems in data processing. These arise from the fact that in certain temperatures and degrees of humidity paper will expand. This can upset the exact alignment of card columns as well as the right stiffness of the card.

The computer is expected to control the many variables—pressures, temperatures, flows—inherent in paper making. With paper travelling at a third of a mile a minute or more these change too rapidly for human adjustment. With the computer, paper making is expected to become a more exact science.

THE Department of Scientific and Industrial Research is to contribute over three quarters of a million pounds (£750,932) towards a new **nuclear physics research centre** at Oxford University. This will provide a particle accelerator of novel design with which Professor Denys Wilkinson proposes to carry out an extended programme of long-term research on nuclear structure. In addition the National Institute for Research in Nuclear Science will carry out the design of part of the accelerator at a cost to the Institute of £200,000, which, with further aid from the University Grants Committee, brings the total government support for the project to approximately one million pounds.

This specially designed equipment will consist of an 8-10 MeV vertical Van de Graaff generator which will be coupled to a 12 MeV horizontal tandem Van de Graaff generator. With the energy that it will produce Professor Wilkinson's group will be able to study the structure of all nuclei. It will be the first of its type in the world.

Equipment of this size and cost must be regarded as a national asset and this accelerator, while primarily provided for Professor Wilkinson's research programme, will, by agreement between D.S.I.R. and Oxford University, be available to other research workers.

EDUCATION

THE latest **film**—**"Transistors"**—to be released by **Mullard,** deals with semiconductor research, manufacture and applications, and will appeal to a wide variety of audiences, both technical and non-technical.

Opening sequences show the automatic control of the destination and speed of shunted wagons by a computer which directs the wagons to their correct sidings.

A simple explanation of the working of semiconductor devices follows, free use being made of animated diagrams to illustrate the functioning of both transistors and diodes.

The main body of the film deals with research and manufacturing techniques used in the development and mass-production of these devices. Examples of the rigorous test procedures applied to the devices before they leave the factory are then shown.

Sequences taken in the research laboratories outline some of the problems undertaken by physicists and chemists working alongside mathematicians and engineers, including the investigation of the crystalline structure of semiconductor materials.

The film closes with illustrations of further applications of transistorised equipments. Among these are soil analysis by electronic means and meteorological observations with airborne apparatus.

The final sequences, of a rocket launching, symbolise the dramatic fields in which transistors are playing an important part.

Total running time is 25 minutes. Available for distribution in 16 mm copies.

THE Oxford University Institute of Education held a one-day conference at Oxford on Saturday, 17th June, to discuss the recruitment of VIth Form grammar school boys and girls to **higher technological education.**

Speakers included Dr. W. Holder, Deputy Chief Scientific Officer, Aerodynamics Division, National Physical Laboratory; Dr. L. R. B. Elton, Head of the Physics Department, Battersea College of Technology and H. A. Davies, M.A., Headmaster, High Pavement School, Nottingham.

In particular, the alleged shortfall in recruitment of sixthformers into higher technological education was examined in the light of the nature of the study of technology, the institutions in which it is pursued and the preparations which have been made at school.

This conference formed part of a study into recruitment for higher technological education made possible by a grant from the Capitol Radio Engineering Institute, Washington, D.C.

EXHIBITIONS, CONFERENCES, ETC.

Electronic control of machine tools was the subject of three symposia organised by the Electronic Apparatus Division of Associated Electrical Industries Ltd., and held from 16th to 19th May, 1961, at New Parks, Leicester.

The symposia were attended by upwards of one hundred and thirty people,

including prospective customers and AEI Manufacturing and District Office personnel. Lectures were given by Messrs. M. Monk, R. Lawson, N. Milne and D. J. Mynall, all members of the Engineering Department, Electronic Apparatus Division, and the delegates were given demonstrations on staircase milling and tracing. Each session concluded with a discussion for which the chairman was Mr. J. A. Stokes, Manager (Leicester), Electronic Control Engineering Department.

In an introductory talk on " Electronic Control of Machine Tools ", Mr. Monk pointed out that his subject was concerned with the machine tool itself in relation to automatic control. Very few machines had been designed specifically for automatic control and existing designs failed to meet a minimum specification in various ways. However, a compromise was often possible, provided that the machine tool manufacturer co-operated in carrying out certain essential modifications.

The factors determining the choice of a machine tool and the necessary modifications were discussed, and Mr. Monk described why it was rarely possible, at reasonable cost, to fit automatic control to an existing machine tool.

Mr. Lawson dealt with " Feed Drives and Tracer Controls ". He referred to the fact that the electronic control of motor speed as applied to machine tools and other industrial equipment was essentially a feedback system in which the actual speed was measured by tachometer generators and compared with the reference voltage. By those means spindle and feed speeds could be set and held steady to very close tolerances, a technique equally applicable to both electric and hydraulic motors. Such systems had other qualities which could also improve the productivity or extend the scope of machine tools, among which were: wide speed range without gear-changes; rapid acceleration and deceleration; finger-tip control; the facility of multiple control stations at virtually any distance or position; accurate indication of speed at little extra cost; the combination of several motions into a single control (e.g. steering); and easy adaptation to pre-programmed sequence systems.

" Co-ordinate Setting as an Aid to Production " was the theme of Mr. Milne's lecture. Fully automatic co-ordinate setting was discussed showing its application to general purpose boring machines and jig boring machines. Initial preparation of the information to be fed into the machine took place in the drawing or planning office. In the case of existing drawings it was possible that they would have to be re-drawn in a form in which the hole positions were expressed in rectangular co-ordinates. From this new drawing a co-ordinating table was prepared in which information was given on the co-ordinate settings and hole diameters. The last stage was the preparation of the punch card from the co-ordinate table.

With this form of machine tool control, the question inevitably asked was " How much time would it save, compared with earlier methods? " Mr. Milne said that there was no unique and easy answer to this seemingly simple question. However, he attempted to provide an answer by taking actual examples of components manufactured on horizontal boring machines and vertical jig boring machines; and concluded with a reference to extensions of the automatic co-ordinate setting control to provide special machining facilities such as staircase milling and dimple milling.

The final lecture on " The ' Numeritrol ' System of Continuous Numerical Control of Machine Tools " was contributed by Mr. Mynall. He pointed out that " Numeritrol " is the name given to the AEI electronic control system developed to effect continuous, co-ordinated control of machine-tool movements from digital recordings on magnetic tape. It covered not only the machine tool and its control gear, but also the special computing programmes and apparatus which, together, minimised the amount of numerical information which had to be handled explicitly by the planner responsible for producing the magnetic recording.

Mr. Mynall's talk dealt with the system from the point of view of application rather than technical detail.

The AEI Electronic Control Group which arranged the lectures hopes that they will demonstrate how the installation of machine tools fitted with these systems can help with manufacturing problems, improving the techniques used and the through-put and accuracy obtained and, thus, in the majority of cases, reduce the production costs.

FILM shows, lectures on metrology and a comprehensive demonstration of measuring instruments and machine tools were presented to West Country industrialists and engineers during a joint exhibition held by the **Société Genevoise Ltd.** and the **Taylor, Taylor & Hobson Division** of Rank Precision Industries Ltd. in Bristol recently.

John R. Adams, of Taylor, Taylor & Hobson, lectured on " Some Aspects of Fine Measurements " and P. A. McKeown on " The Development of Line Standard Metrology ".

THE sixteenth annual **Electronics, Instruments and Components Exhibition and Convention** of the Institution of Electronics will be held at the College of Science and Technology, Manchester, 1, during the periods 6–8th and 10–12th July (inclusive), 1961.

This exhibition and convention will incorporate a scientific and industrial research section, a manufacturers section and a programme of lectures and films on the topics of electronics, instruments and components.

THE third **International Congress on Cybernetics,** organised by the International Association for Cybernetics, will be held at Namur (Belgium), from the 11th to the 15th September, 1961.

Five themes will be considered, each theme being studied by a special section:

1. The bases and methods of cybernetics
2. Semantic machines
3. Automation: technical aspects
4. Automation: economic and social aspects
5. Cybernetics and life.

A general opening conference will be given by M. Georges Villiers, President of the French National Employers' Council.

Further information may be obtained from, Secretariat de l'Association Internationale de Cybernétique, A.S.B.L., Rue Basse-Marcelle, No. 13, NAMUR (Belgium)

ON 13th and 14th June, Elliott Brothers (London) Ltd. held a private symposium and exhibition on **Analytical Instrumentation of Industrial Process Control.**

At the symposium, papers were read by Mr. K. E. Hallikainen, President of Hallikainen Instruments, of Berkeley, California, on "The Application of Analysis Instruments in the U.S.A." and by Mr. D. J. Fraade, Head of the Applications Laboratory of the Analytical and Control Division of Consolidated Electrodynamics Corporation, Pasadena, California, on " The Continuous Measurement of Moisture ". Papers were also read by Mr. L. Farey, of the Mobil Oil Co., on " Analysis Instruments from the Point of View of the User " and by Mr. J. Mawson on " Experience with Plant Stream Analysers at Imperial Chemical Industries, Billingham ". Mr. T. R. Mills, Chief Engineer of The Analytical Instruments Division of Elliott Brothers (London) Ltd., spoke on " Trends in Continuous Process Analysis".

There was on exhibition a wide selection of the extensive range of quality control instruments supplied by The Analytical Instruments Division of Elliott Brothers (London) Ltd.

THE emphasis placed by electrical manufacturers on increasing their exports is reflected in the programme arranged by the **British Electrical and Allied Manufacturers' Association** for the BEAMA Golden Jubilee Export Conference to be held at the Connaught Rooms, London, on 5th and 6th October.

The President of the Board of Trade will speak at the Conference Luncheon, and on the first day there will be papers by leading authorities followed by discussions on electrical engineering and problems of trading with Europe and the Western Hemisphere.

The session on the second day is reserved for a series of discussion groups on subjects of vital importance to all exporters. Each group will have a chairman who is a member of the BEAMA Export Panel, and two discussion leaders. Subjects covered by the discussion groups will be: finance for export; market research; standards and practice and designs for foreign markets; the changing pattern of overseas trade; export publicity, advertising and fairs.

The Conference Chairman will be Mr. Leonard Short, M.C., Chairman Designate of the BEAMA Export Panel and Director of Overseas Operations of The English Electric Co. Ltd.

THE **Stockholm Components Show** organised by the Radio & Electronic Component Manufacturers' Federation will be held from 9th - 13th October. Last year sales of British components to Sweden and Norway were more than double the 1959 figure.

INSTRUMENT APPLICATIONS

Automatic Carburising by Standard-Triumph

A MODERNISATION scheme to provide fully automatic control of carburising and carbo-nitriding furnaces has been completed by the Standard-Triumph organisation at their Fletchamstead and Radford Works, Coventry. The scheme uses the endothermic gas technique.

Main shafts, gear wheels, pinions, differentials, cluster gears and similar parts require careful hardening if their dimensions and metallurgy are not to suffer. Using the new scheme, the company finds that certain gear wheels are retaining their dimensions to some 0·004 in. accuracy and have a surface finish after nitriding that makes them suitable for assembly direct into vehicle gear boxes.

Both factories incorporate precisely controlled quenching after treatment; at Fletchamstead the quenching is embodied in the furnaces and at Radford press-quenching is a separate operation.

There are four single-zone Wild-Barfield furnaces at Fletchamstead with carburising and stabilising time controlled by four sets of instruments on a large panel. A Honeywell electronic strip chart recorder/controller inter-operates with two process timers which reset themselves after completion of the cycle. Carburising normally takes place at about 940°C and carbo-nitriding at around 815°C. Each set of instrumentation includes a section housing manual controls for the ammonia, propane and air producing the endothermic gas. There are also Pyr-O-Vane instruments by Honeywell which indicate and cut off fuel flow under excess temperature conditions, similar instruments safeguarding the gas generator elsewhere.

The panel also includes Honeywell controllers for two 160°C tempering furnaces.

A separate recorder/controller keeps oil supply temperature constantly at 55°C to within 1°C, and during quenching a Burrell process timer on each furnace keeps the oil temperature steady.

Dewpoint control is provided by Foxboro-Yoxall circular chart controllers.

Automation of a different kind is provided on two G.W.B. three-zone carburising furnaces at Radford, where an 85 ft panel includes both automatic and push-button control. The automatic control for each furnace is provided by three Honeywell circular scale controllers, one per zone, and a permanent record is given on a multipoint strip chart recorder alongside. Zone temperatures are respectively in the region of 820, 840 and 920°C A further two Honeywell recorders give tempering furnace temperatures and quench temperatures. Quenching takes place on Gleason presses, the moment of quench being determined by Honeywell contact controllers which start the quenching cycle when the work-piece temperature falls to a given level, as detected by a Radiamatic radiation pyrometer.

Control of the endothermic gas temperature of 1040°C is obtained to a closeness of ±2°C by a controller from the same supplier. Dewpoint is controlled by Foxboro-Yoxall instruments as at the other factory.

The manual control is provided and an alternative on a console desk, one per furnace.

Circle **76** *for further details.*

Automatic Frequency Measuring System

SAVINGS of up to £200 per operator can be effected in the production testing of crystal filters, oscillators, h.f. coils and chokes and other components where highly accurate frequency measurement and indication is essential. Racal Instruments, in order to reduce the expense involved in equipping each operator with frequency measuring test equipment, have devised a completely automatic frequency measuring system which is ideally suited to the production test environment.

Using only one frequency meter with in-built translator control panel, the system enables accurate (±1 count ±1 part in 10^7) frequency measurements in the range 0—10 Mc/s to be made automatically by up to six operators, each operator having a separate in-line digital display unit. Under certain conditions the frequency range can be extended to higher frequencies.

Comparisons of costs show that where the equipping of six operators with conventional equipment would cost close on £4,200, the Racal system for the same number of operators is in the region of £3,000, dependent upon the "tailoring" of the equipment to the customer's requirements.

The added advantages of the system are that full use is made of the test equipment, the operators' are not "cluttered" with expensive apparatus, indication is made in easily-read in-line form, and additional readout units can be added at little extra cost.

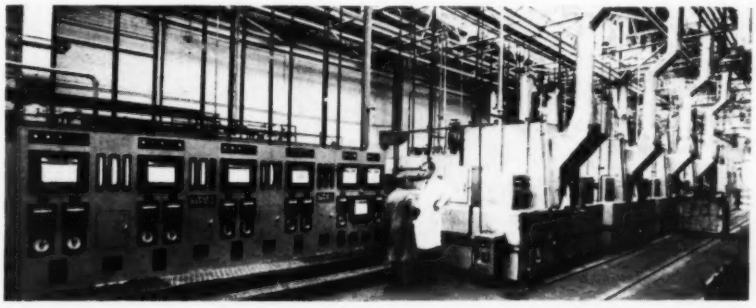
The Racal installation comprises a Type SA.505 digital frequency meter, with its own built-in translator control panel, and the desired number of remote in-line readout panels, together with necessary control and automatic sequencing circuitry.

The automatic control panel provides a queueing mechanism so that the equipment can be used to its full capacity according to the type of installation and facilities required in the system.

Each remote position is fitted with a control panel enabling the operator to "call" the counter and make a frequency measurement. The measurement is displayed in illuminated numerals and each indication is held for five seconds. The terminal equipment is fitted in a standard 19 in. rack or can be bench mounted if desired.

A similar installation using a Racal SA.21B digital counter has been installed for a 6-position production test bench for crystal filters at Marconi's Chelmsford Works. With a 3½ second display time, indication is given of frequencies based on a 100 kc/s fundamental. The in-line readout is fitted to Marconi's own scanning rack and the comparatively short display means that with all operators using the system the maximum queue is only 17½ seconds.

Circle **77** *for further details.*



Automatic carburising and carbo-nitriding at the Fletchamstead works of Standard-Triumph where gear wheels emerge from four single zone furnaces dimensionally very accurate and suitable for assembly without further treatment. Honeywell instrumentation forms the basis of the control systems.

Transistorised

carrier systems

Standard 19" rack unit fitted with a mains supply unit, 3 kc/s oscillator, four demodulators (two with calibrated dials, two without), and two carrier amplifiers. This carrier amplifier, for example, provides two outputs of ±3 mA into 100 ohms and ± 2V into 100 kohm simultaneously for a change of resistance of 2 × 10⁻⁴ in its bridge input.

S.E. Laboratories offer a range of fully transistorised rack-mounted equipment, ideal for amplifying and presenting information from inductive and resistive transducer devices to indicators, recorders, oscilloscopes and data logging instruments.

These SEL systems are based on well-tried circuits used in the missile and aircraft fields, and combine miniaturisation with high stability and accuracy.

* **Fully transistorised**
* **Printed circuit reliability**
* **Miniature size**
* **Robust, interchangeable units**
* **High stability and accuracy**
* **Two- or four-arm inductive or resistive bridges**
* **Frequency response DC – 500 c/s**

For full details of these and other S.E.L. products—transducers for pressure, acceleration and displacement, control and venting valves, frequency/DC converters, flowmeters, U.V. recorders, etc., contact:

S.E. LABORATORIES (ENGINEERING) LTD

North Feltham Trading Estate, Feltham, Middlesex. Telephone : Feltham 5876

Rapid High Accuracy Analysis of Oils

YOUNGHUSBAND STEPHENS & CO. LTD. have recently installed Pye gas liquid chromatography equipment. The high sensitivity argon ionisation detection system allows rapid and accurate analysis of raw materials, control of process methods, and also provides a new basis for further research work.

The percentages of fatty acid constituents are determined during the analysis of raw materials, allowing the oils to be used for the manufacture of products most suited to the constituents present. For example, in the case of linseed and soya oils, the percentages of linoleic and linolenic fatty acid are determined to a high degree of accuracy, enabling oils with the maximum drying or non-yellowing properties to be selected.

Other oils such as rape seed, tobacco seed, boiled and blown oils and polymerised oils are chromatographed and analysis figures are usually available within one hour of a sample being taken. During processing more detailed information of process efficiency and treatment techniques can now be obtained owing to the rapid analysis performed by the Pye equipment.

One of the current projects included in the extensive programme of research being carried out in the Younghusband Stephens laboratories is the investigation of unpolymerised fatty acids during the heat treatment of oils. In this, and other projects being carried out, a considerable amount of analytical information is being made available, assisting in new and improved products for the paint industry.

Circle **78** *for further details.*

Drilling Printed Circuit Boards

AN electronically-controlled drilling machine equipped with a multi-spindle head has paid for itself by the saving of tooling costs on its first job. For future jobs, the only extras will be the negligible cost of new tapes, and in all cases design modifications can be made much more cheaply than when using conventional drilling methods.

Altering a jig can take up to ten hours but a new tape can be made in fifteen minutes.

The problem was to make varying numbers of holes in small batches of printed circuit boards of several different designs. An EMI-Grimston positioning table, supplied by EMI Electronics Ltd., was equipped with a seven-spindle drilling machine which was also controlled by the EMI system. The positioning equipment uses a measuring element with an electrical accuracy of $\pm 0{\cdot}0005$ in., which gives a guaranteed positional accuracy of the table of $\pm 0{\cdot}002$ in. with repeatability to $\pm 0{\cdot}001$ in.

Information can be fed into the system by punched tape or set up on dials.

A removable baseboard is loaded with seven packs, each of five printed circuit boards, located by datum holes on pins, and then fixed to the table. The x ordinate is read and the table moves in the x direction and is locked. The y ordinate is then read and the table moves in the y direction and is locked. The spindle feed is actuated and drilling takes place. The cycle is repeated for the second hole. The reading of the x ordinate starts while the spindles are retracting.

Duplicate baseboards facilitate unloading and reloading of one while the other is on the machine, thus ensuring maximum machine utilisation.

Circle **79** *for further details.*

Aircraft Nosewheel Steering

DESIGN characteristics of recent military and civil aircraft have shown the need to incorporate accurate and reliable nosewheel steering, which in addition to normal taxying duties supplements conventional controls during take off and/or landing.

The remote control system developed by Dowty Electrics Ltd. primarily for aircraft nosewheel applications is intended for use with all forms of steering motors and consists of three basic elements:

(a) Pilot's control (Input)
This is a simple resistance-type transducer coupled directly to the rudder-bar or special steering wheel.

(b) Follow-up transducer
This is also a simple resistance-type transducer connected to the steerable nosewheel.

(c) The control panel
In its simplest form the control panel incorporates a transistorised amplifier and associated slave relays which control the steering motors through solenoid valves or further heavy-duty relays when an electric steering motor is used.

In operation the input and follow-up transducers are connected to form a simple Wheatstone bridge circuit, which is polarised from a direct current supply. The transistorised amplifier is the sensing element in this circuit and operates the slave relays in response to error signals produced by asymmetrical displacement of the moving transducer contact blades. A high degree of sensitivity is afforded by this arrangement so that it is usual to provide a variable "amplifier gain" control to allow stability adjustment of the complete system.

Dowty Electrics Ltd. offer a range of nosewheel control systems which are readily adapted to existing or new aircraft, and which cater for widely varying aircraft characteristics—some of the available unit variants are outlined below:

(i) The follow-up transducer can be supplied with special switch sectors which are connected, to prevent undercarriage retraction until the nosewheel is correctly centred.

(ii) By using an alternative circuit arrangement, a wide range of non-linearity may be introduced to provide, for example, decreased sensitivity in the centre position, e.g. angular movement of the pilot's control can be increased in relation to a given movement of the nosewheel about its centre position. Alternatively, by introducing a pilot-operated switch, the steerable angle and sensitivity can be readily changed to suit both high and low aircraft ground speeds.

Two basic types of control panel are available: single channel or two channel systems. The latter provides double pole switching and is normally used for aircraft applications. The two channel system uses twin-track input and follow-up transducers, each forming an entirely separate bridge circuit with twin transistorised amplifiers. In operation these two channels electrically monitor each other and final steering control is dependent on the agreement of both channels. When fault conditions occur, the steering control is removed and the nosewheel reverts to free castoring by the release of solenoid operated by-pass valves or clutch mechanisms.

Circle **80** *for further details.*

Control for Electric Underfloor Heating

THE Satchwell Ratiomatic is a control system for the automatic regulation of the duration of charge supplied to a domestic electric underfloor heating system during an off-peak period.

The control of such heat storage installations presents a particularly difficult problem since the heat emission cannot be controlled as in other forms of heating and it is only possible to govern the charge that is fed into the heated floor, to be liberated during the following twelve hours.

The Ratiomatic employs two temperature detectors, one mounted outside the building and the other inside, and the charging period is regulated according to the temperature measured by them in combination. The system provides an infinitely variable charge which may be anything between 100% and zero.

Intermediate charges between fully ON and OFF are provided by a cyclic switching action, the proportion of time that the floor heating is switched on during the charging period determining the amount of the charge. The outside unit not only measures the air temperature but takes into account the effect of wind on the building as well. Also the room thermostat is arranged so that it increases the charge for a fall in room temperature but incidental rises in temperature above the desired level do not reduce the charge.

It has been found by experiment that when a large mass of material is being used as a heat store (as in a floor heating system) no advantage is gained by delaying the charge until the last possible moment in the charging period and consequently no clock mechanism is necessary. The Ratiomatic is, in fact, a simple system employing two small units which can be installed in the most convenient and suitable positions since they are connected only by wiring. They are simple, too, to set—only two temperature dials—and these can be adjusted on site or re-set at any time to suit the building characteristics and the householders' preferences.

Circle **81** *for further details.*

Circle 360 for further information

MS FLUID FACTS

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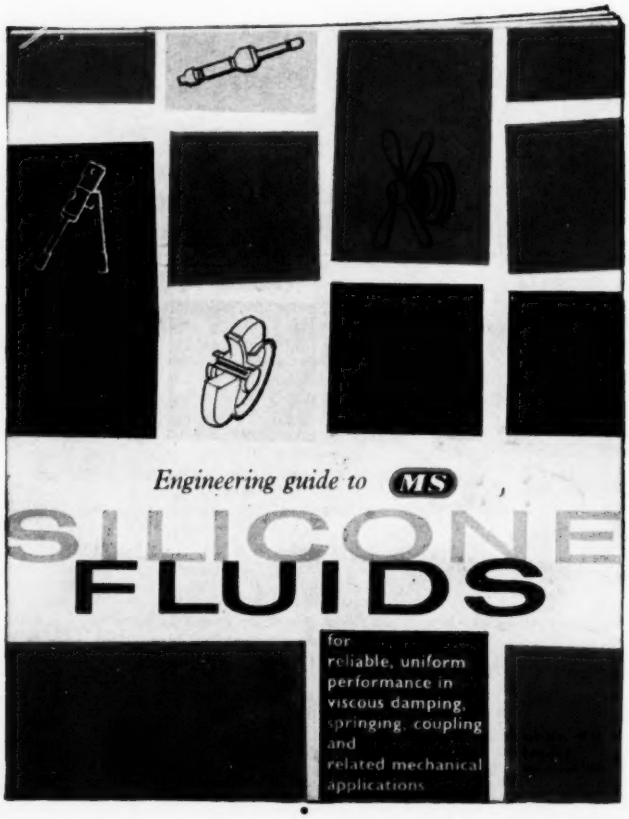
If your requirement is more for silicone lubricants and greases then 'Silicone Lubricating Fluids & Greases' (G 14) *is the publication for you.*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PERSONALITIES

Mr. R. H. Wilson

Mr. R. J. Bailey

Mr. R. H. Wilson has been appointed to the board of directors of CIBA (A.R.L.) Ltd. Mr. Wilson, who joined the company (then known as Aero Research Ltd.) in 1954, was initially associated with the development of " Araldite " epoxy resins and was appointed general sales manager last year.

Professor Sir Bernard Lovell, O.B.E., F.R.S., Professor of Radio Astronomy at the University of Manchester and Director of the Nuffield Radio Astronomy Laboratories, Jodrell Bank, has accepted the appointment of Scientific Adviser to British Space Development Company.

His services as Scientific Adviser to the British Space Development Company will be of great value to the company's technical committee which is engaged in detailed investigations into ways and means of launching a British space programme for communication satellites in the near future.

Two Scientific Attachés have been appointed by D.S.I.R. One is an entirely new post of Scientific Attaché to the British Embassy in Tokyo to advise the British Ambassador on scientific matters and to report on Japanese scientific and technical development in the civil field. The other is the appointment of a successor to Mr. G. H. Greenhalgh, whose tour of duty as Scientific Attaché to the British Embassy in Stockholm ends soon.

Dr. Charles Manders, aged 54, has been selected to fill the Tokyo post. He will hold the rank of Senior Principal Scientific Officer and joins the Department of Scientific and Industrial Research from the Ministry of Defence.

The new Scientific Attaché in Stockholm will be **Mr. William Drury.** He joins the D.S.I.R. from the Royal Naval Scientific Service, where he is currently scientific assistant to Sir John Carroll, Deputy Controller (Research and Development). Mr. Drury, who is 43, will also hold the rank of Senior Principal Scientific Officer.

The following appointments have been made to the board of the Consolidated Pneumatic Tool Co. Ltd.

S. H. Ireland—assistant managing director.
L. S. Bright—financial director.
A. O. Miller—director.

Mr. C. R. Thompson has recently been appointed an executive director of Pye T.V.T. Ltd., Cambridge.

Mr. R. J. Bailey has been appointed vice-president of The English Electric Corporation in New York. This newly-formed corporation centralises the U.S.A. activities of The English Electric Group, including Marconi Instruments of which Mr. Bailey has been U.S. manager since 1954. He joined Marconi Instruments in 1938 as a junior sales engineer and served in the Royal Navy during the War. In 1946 he rejoined Marconi Instruments and was manager of their London office before going to America.

Following reorganisation of Associated Electrical Industries Cable Division, **Mr. J. S. A. Bunting,** formerly joint divisional general manager, has been elected to the board of Associated Electrical Industries (Woolwich) Ltd. AEI Cable Division is one of the four AEI Product Divisions in the Woolwich Group.

The following appointments have also been made in AEI Cable Division:

Mr. E. J. Vidler, divisional general manager and director of AEI divisional management company.
Mr. F. V. Vaissiere, divisional commercial manager.
Mr. V. L. J. Plascott, divisional manufacturing manager.
Mr. W. G. Hawley, divisional chief engineer.

The operation of AEI Cable Division is now organised into four Product Groups: Power Cable (Sales manager—Mr. K. S. Estlin); Super Tension Cable (Sales manager—Mr. R. G. Holland); Rubber and Plastic Cables and Wires (Sales manager—Mr. D. Beavan); Distribution Equipment and Accessories (Sales manager—Mr. H. Hubbard).

Mr. Charles A. Moore has been appointed to the board of U.S. Industries Inc. (Great Britain) Ltd.

Mr. Moore, who is 51, is already a director of Burtonwood Engineering at Warrington, Lancashire, a subsidiary of U.S.I. He is chairman of the board and principal sales executive of Manning, Maxwell & Moore Inc., a manufacturing company in Stratford, Connecticut, which produces a wide range of industrial products including gauges, valves and instruments, cranes, various types of hoists and related accessories.

The Wayne Kerr Laboratories Ltd. have recently appointed **John O. Viccari** as manager of their headquarters sales office at New Malden.

Major E. R. Wilcox has been appointed research and development liaison officer.

Sir Edward Playfair, K.C.B., has been appointed chairman of International Computers and Tabulators Ltd., with effect from the 1st August next, when he will be released from the post of Permanent Secretary to the Ministry of Defence.

Dr. R. Conrad, assistant director of the Medical Research Council's Applied Psychology Research Unit at Cambridge, will act as **consultant in applied psychology to the Post Office** for an initial period of two years.

The following examples show the kind of problems on which the Post Office is obtaining specialist physiological and psychological advice:

An important study is being carried out to determine the best layout for the keyboard that controls a letter-sorting machine. Specialist advice is also being sought to help decide the optimum periods of continuous working for staff employed at these machines. Certain other investigations aim at ensuring the staff do not suffer any avoidable fatigue or eyestrain.

Studies that are being carried out to determine the best method of coding the addresses on letters are also of considerable importance in the further mechanisation of the postal service.

Specialist psychological advice has proved most useful in connection with the operation of a new type of switchboard; this advice has enabled more effective and economical methods of assessing operating requirements in the use of this type of switchboard. The new consultant in psychology is also building up information about the performance both of operators and of the public generally, in memorising numbers, with a view to determining ways in which errors might be minimised. He is also considering problems of the presentation of information and instructions to subscribers and operators.

Solartron have appointed **Norrie McFarlane** as regional manager covering Scotland and Ireland.

Major E. R. Wilcox

Mr. N. McFarlane

Hilger & Watts Ltd. announce that **Mr. A. H. Campbell, M.A., M.I.E.E.,** who has been a director of the company since 1951 and general manager since 1954, has been appointed joint managing director with Mr. G. A. Whipple, M.A., M.I.E.E., F.Inst.P.

Hilger & Watts Ltd. have recently appointed two more representatives.

For Scotland, they have appointed **Mr. Alastair Campbell, B.Sc.,** whose base will be the offices of Elesco Electronics Ltd., 2 Fitzroy Place, Glasgow, C.3; Tel. Glasgow Central 1082.

For the Midlands, **E. R. Sayer, B.Sc., Ph.D.,** has been appointed. His address is 32 Mountford Crescent, Aldridge, Nr. Walsall, Staffordshire; Tel. Aldridge 53151.

Mr. Norman Readman, managing director of the Consolidated Pneumatic Tool Co. Ltd., has been elected president of the Chicago Pneumatic Tool Company, New York, to succeed Mr. Guy J. Coffey.

Mr. Coffey becomes chairman of the Board in succession to Mr. H. Arnold Jackson who has retired, although remaining a director and chairman of the Executive Committee.

Mr. Readman leaves for New York in September.

British Insulated Callender's Cables Ltd. have appointed **Mr. A. W. Thomson, A.M.I.E.E.,** as technical manager of BICC-Burndy Ltd., Prescot, Lancs. His duties include the design, development and application engineering of all BICC-Burndy products.

Mr. L. A. Thomas, B.Sc., F.Inst.P., A.M.I.E.E., has been appointed chief physicist at the Hirst Research Centre of The General Electric Co. Ltd., Wembley, Middlesex.

The following board changes have taken place in the English side of General Controls Co., **Remy H. Ludwig** has resigned as director, and **Jack F. Ray** has joined the board.

Mr. E. B. Augood, A.M.I.E.E., A.M.I.Mech.E., has been appointed works manager to Ultra Electronics Ltd. Mr. Augood was previously with the Morgan Crucible Group for many years, his last position being that of managing director of Morgan Components Ltd. at Stanmore, Middlesex.

The company also recently appointed a new projects officer in the Control and Instrumentation Division, **Mr. Ronald G. Mammatt,** previously with Cosmorcord Ltd.

Mr. D. Major, B.A., B.Sc., has been appointed assistant chief engineer of the X-Ray Department of Instrumentation Division, Associated Electrical Industries Ltd.

Professor Maurice G. Kendall is to join the Board of C-E-I-R (U.K.) Ltd., the computer research services organisation. His election will take effect from 1st October, 1961, and he will be responsible for the Departments of Mathematics, of Statistics and of Operational Research and their activities. He will work closely with Dr. Alexander S. Douglas, the Director of Technical Services, whose divisional responsibilities include Departments of Computer Services, of Computer Technology and of Programming.

Dr. Maurice G. Kendall is at present Professor of Statistics in the University of London and will vacate his chair on the 30th September, 1961.

Mr. R. F. Hockin, A.C.W.A., A.M.I. Mech.E., has resigned from the board of Burtonwood Engineering Co. Ltd., in order to devote more time to his other interests.

A central Publicity Department has been set up at Hawker Siddeley Aviation with **Alec Hicks** as manager. The new department will control and co-ordinate all Advertising, Public Relations, Exhibitions and Publications for the big aviation combine. **Jim Corfield** has been appointed public relations officer in the new set-up which will report to the HSA Sales Director, J. A. R. Kay.

Assisting him will be **Mr. David Masters,** former production test pilot with Fairey Aviation at Manchester, who will fill a new appointment as technical press officer.

Cambridge Instrument Co. Ltd. have appointed **Mr. K. J. Bush, A.M.I.E.E.,** as assistant sales manager, Mechanical Thermometer Division, Friern Park, N. Finchley.

Mr. W. C. Orford, Mr. S. V. J. Crump and **Mr. W. A. Hall** have been appointed as assistant resident engineers at the company's branch offices in Nottingham, Bristol and Manchester respectively.

J. Sharpe, B.Sc., A.M.I.E.E., of EMI Electronics Ltd., was chosen by the Russian authorities as the sole representative of the Scientific Instrument Manufacturers' Association at the British Trade Fair, Moscow, to give a technical lecture to a Russian audience. Mr. Sharpe is manager of the company's special electronic valve and tube division and the subject of his paper was "Photomultipliers and their Applications".

The lecture covered such points as design and characteristics of photomultiplier tubes, and their specialised modification for particular applications.

SOCIETY OF INSTRUMENT TECHNOLOGY

Grangemouth Section

THE Grangemouth Section held a well attended Annual General Meeting in the Leapark Hotel, Grangemouth, on the 16th March, 1961, and they were pleased to welcome Commander A. A. W. Pollard, the Society's secretary as their honoured guest.

The minutes were then read by the secretary, Mr. S. Blake, and mention was made of the encouraging growth in membership during the past year.

The chairman, Mr. H. Slack, gave his report on meetings held at the Central Council, and the Local Chairman's Committee where it appears considerable work is still being done on training programmes, and educational proposals. The meeting was interested to hear of a Government White Paper on "Better Opportunities in Technical Education" which proposes some changes in titles and modifications to length of courses. It was said that a Scottish regional committee would investigate the possibility of organising a symposium of one day following suggestions given by the Central Council. The chairman proposed a vote of thanks to the executive committee and, in mentioning the work they had done, hoped that the success of the past Annual Dinner would prompt the members to have a similar function in the coming year.

After the balance sheet had been presented by the treasurer Mr. S. Skilling, the officers were elected.

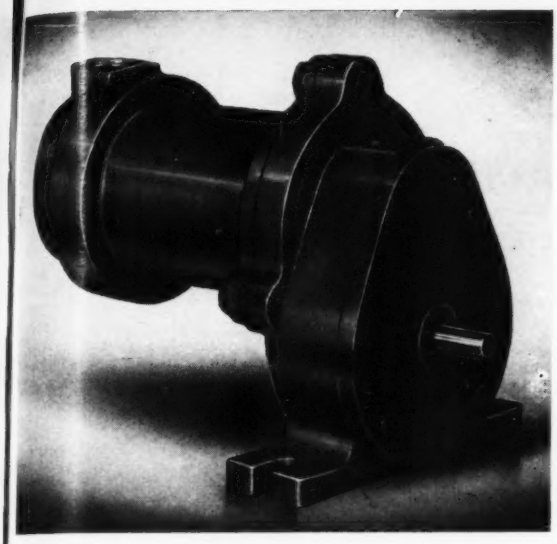
Chairman:	Mr. E. Worsley
Vice-Chairman:	Mr. G. Williams
Secretary:	Mr. S. Blake (re-elected)
Treasurer:	Mr. J. Grindley
Recorder:	Mr. F. B. P. Jowett (re-elected)

The retiring office bearers were Mr. H. Slack, the chairman, who was proposed and nominated for immediate past chairman, and Mr. S. Skilling the treasurer.

The retiring committee members are:
Mr. J. Bulloch
Mr. G. Williams
Mr. G. Kay

New elected committee members are:
Mr. F. B. P. Jowett
Mr. D. Chisholm
Mr. R. Livestone

Circle **361** for further information



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Other leading data includes:—

Winding	Three-phase, star-connected
Terminal Resistance	260 ohms
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Brief details of other tachogenerators, magslip transmitters and servo motors are given in Publication 444

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Circle **362** for further information

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NYLON TUBE COUPLINGS

Simple! Secure! Speedy!

Simplifix Nylon Tube fittings are dependable, practical and economical. They are easily and quickly fitted. No work is needed on the end of the tube because the specially designed brass olive ensures a perfect seal and prevents the tube twisting when the joint is made. The coupling bodies are the same as those used for copper tube. Olives and securing nuts can be supplied separately. Only one stock of bodies is needed to make up fittings for Copper or Nylon Tube. Simplifix Nylon Tube couplings, olives and securing nuts are available for O.D. tube sizes of $\frac{3}{16}$", $\frac{1}{4}$", $\frac{5}{16}$", $\frac{3}{8}$" and $\frac{1}{2}$". Nylon Tube for these couplings can be supplied in a wide range of colours.

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The meeting joined the new chairman, Mr. E. Worsley, in thanking the past chairman, Mr. H. Slack, for the first class way he had worked through difficult times when the section was being formed in the early days, and up to the present day.

The members paid their farewell wishes to Mr. S. Skilling who is leaving to take up a new post, and thanked him for the efficient way he had performed his duties as treasurer.

This concluded the business of the Annual General Meeting.

The rest of the evening was enjoyed by the showing of three interesting films on the theory of a simple type p-n-p transistor, the construction and manufacture of transistors, and the theoretical equivalent circuits describing transistor functions.

Manchester Section

At the Annual General Meeting of the Manchester Section, held on the 15th May, 1961, Dr. Stainthorp thanked Dr. A. W. Foster for his past two years' services as chairman of the Manchester branch. The new committee were elected by the meeting which is headed by:

Chairman:	Mr. G. D. Coombes
Deputy Chairman:	Dr. Stainthorp
Secretary:	Mr. R. Maley

The A.G.M. was followed by a paper given by the retiring chairman, on thermocouples, to an audience of over thirty members. Dr. Foster dealt with the atomic theory of thermo-electrics, crystal structure of thermocouple wires, the various alloys employed, and also explained the Curie point. He also went into the testing of thermocouple materials and the effect of thermocouples in nuclear reactors, and finished his talk on the standardisation of wires.

Tees-side Section

In the presence of eleven members and no visitors Mr. B. W. Ramsay, Section chairman, opened the 100th Ordinary Meeting and introduced the speaker for the evening, Dr. L. Essen, of the National Physical Laboratory.

Dr. Essen opened his lecture entitled " The Atomic Clock " by first describing astronomical methods of calculating time from the movement of stars. This was followed by the quartz clock which, although it could be read to an accuracy of 1 in 10^{10}, could only be calibrated to 1 in 10^{8}. The atomic clock, first developed at the N.P.L., provided a means of utilising the full accuracy of the quartz clock as a sub-standard.

The speaker outlined the construction of the atomic clock, stressing its basic simplicity and reliability. This was followed by a short film illustrating the points already made.

Application of the atomic clock, apart from its use as a standard, included accurate timings of multi-station radio transmissions and in the provision of a uniform time for the tracking of satellites, for example.

Mr. D. H. Whiting opened a lively discussion and this was followed by a warmly supported vote of thanks from Mr. R. W. Dean.

MANUFACTURERS' LITERATURE

Sealed Quench Slipper Furnace

The sealed quench slipper furnace dealt with in leaflet SQS.960 available from Wild-Barfield Electric Furnaces Ltd., has been designed for clean hardening small components under controlled conditions. Abridged specification and a diagram of their dimensions are also included.

Circle **82** *for further details.*

Governor

This precision built govenor, which has been designed primarily for use with the recording flame methanometer Type 208C, is described in leaflet No. 200, available from Sigma Instrument Co. Ltd.

Details are given of operation and there are also performance charts of a typical governor.

Circle **83** *for further details.*

Use of Electronic Computers

A series of articles which appeared in *The Local Government Chronicle* have now been reprinted under the collective title " Electronic Computers and their use by Local and Public Authorities ".

The types of equipment used, which covers the main computer manufacturers, and trends in the development of computers are described.

Circle **84** *for further details.*

Super Permo

Super Permo is an extremely high quality product comprising 99·7% pure iron which has high magnetic permeability with low remanence and coercive force properties, these factors are essential in electro-magnet parts where high magnetic induction is required.

A leaflet from Samuel Osborn & Co. gives details of the composition, heat treatment, machining applications and forms supplied.

A curve is also given showing magnetism before and after annealing.

Circle **85** *for further details.*

Relays

Ericsson Telephones Ltd. has recently produced a folder containing a number of brochures and data sheets describing and illustrating, in general terms, some of the numerous types of relays. This range covers miniature, polarised, plug-in, chopper and telephone type relays. There is also a brochure for cross-reference which includes Joint Services catalogue numbers and Ericsson codes.

Circle **86** *for further details.*

Controller

Technical publication No. S/262 from Wallace & Tiernan Ltd. describes the new automatic chlorine residual controller. Since its introduction ten years ago the automatic chlorine residual control has come to be accepted by interested authorities as a logical development from dosing in proportion to flow. This new controller system has been developed to meet the many new problems encountered in modern conditions.

Circle **87** *for further details.*

De-rusting Materials

Preperite covers a range of general purpose materials for the removal of rust from iron and steel and corrosion products from non-ferrous metals. The two solutions available are Preperite No. 1, and No. 3. Preperite No. 1 is an unhibited solution and conforms to the Ministry of Defence Specification DEF-36; Preperite No. 3 is an inhibited solution and conforms to Ministry of Defence Specification DEF-37. Also mentioned in a leaflet from the Pyrene Co. Ltd. is paste Preperite, a new product suitable for spot de-rusting where it is unnecessary or inconvenient to immerse the complete component in a solution. The last in the range is Proclean No. 201 for removing the scale and sludge formed on heating coils, etc., in Bonderizing and Parkerizing plants and similar installations, or as a de-rusting solution.

Methods of use, scope and advantages are also included.

Circle **88** *for further details.*

Mark 3 Multelec

The recently introduced Mark 3 Multelec electronic strip-chart instrument is described in publication No. 295 from George Kent Ltd.

The Mark 3 utilises the same electronic components and system as Commander KE instruments; having amplifiers, reference unit, servo motors, slidewires, etc., in common, thus enabling a rationalised approach to be made to maintenance.

These instruments are available in single 2-, 3-, 4-, 6-, 8-, 12- and 16-point forms with clear indicating scale and 10 in. (254 mm) nominal pen-travel chart for temperature and millivoltage measurement.

Specification and performance together with dimensions and mounting details are included.

Circle **89** *for further details.*

Picture Monitor

The Cawkell Tele-remscope, Type TR1, is an entirely new television picture monitor which freezes one picture from a moving sequence. Any number of fields up to eight may be retained as required and the image can be expanded in both the horizontal and vertical directions to allow detailed inspection of a portion.

Specification together with an illustration are included in P. No. TR1/A4/1361

from Cawkell Research & Electronics Ltd.
Circle **90** *for further details.*

Chronsistor

Chronsistor is a compact, extremely light and inexpensive electro-chemical elapsed time indicator. It resembles an electro-plating bath, but on a sub-miniature scale, the dimensions corresponding with those of a standard fuse cartridge to RCL 261, and will therefore fit any fuse holder which takes 1·25 in. long, 0·25 in. diameter cartridges.

Details regarding principle of operation and typical applications are described in a leaflet recently published by Transipack Electronic Engineers.

Circle **91** *for further details.*

Transipack

Transipack Electronic Engineers have issued a brochure concerning their semi-conductor converter. It transforms 6, 12, 18, 24, 28 or 32 V d.c. into higher d.c. or a.c. voltages without the disadvantages inherent to rotating or vibrating systems. The Transipack is available in hermetically sealed or open construction.

Further details regarding technical description, accessories and a whole page specification are given.

Circle **92** *for further details.*

Stub Synchros

The Ellsyn stub synchros are for use in closed loop servomechanisms where space is at a premium. Publication W.26 issued by the Servo Components Division of Elliott Brothers (London) Ltd., gives details of the electrical and mechanical specifications and also includes a circuit diagram.

Circle **93** *for further details.*

Moore & Wright (Sheffield) Ltd.

This company has recently issued two new and revised catalogues dealing with precision and hand tools. The contents of both are exactly the same, enabling one price list to be used for both. One is a good quality large sized catalogue which has been produced for stockists, agents and distributors, while the other is a smaller, cheaper edition for general distribution.

Circle **94** *for further details.*

Contact

Contact, 1 (1) is the first issue of Bowthorpe Holdings Ltd.'s journal. Brief mention is made of compression jointing of thermocouples, and among the Hellerman products noted are the mark counter and Griptite terminals.

Circle **95** *for further details.*

Standard Headed Contacts

Johnson, Matthey & Co. Ltd. have revised the data sheet describing their standard range of contact rivets. As previously, the entire range is normally stocked in silver and in addition a limited range of sizes is now stocked in platinum, palladium, 40% copper-palladium, 40% silver-palladium, 10% iridium-platinum, and Elkonite D54X.

Recommendations are now made regarding the shank lengths required for riveting to various thicknesses of contact support.

Circle **96** *for further details.*

C. A. Norgren Ltd.

The latest literature from C. A. Norgren Ltd. includes a new price list, a pressure regulator catalogue covering their range of pressure regulators for air, non-corrosive gases, water and oil, and "Helpful Engineering Information".

The information sheet gives details of the basic properties of air and recommends the maximum flow that should normally pass through standard medium weight pipe as fitted on a compressed air system.

The leaflet includes a compressed air flow chart and a table on the back page shows the equivalent size of copper pipe that may be preferred to steel pipe.

Circle **97** *for further details.*

Control for Industry

This new publication has been produced by Lancashire Dynamo Electronic Products Ltd. The significance of automatic control of industrial processes is clearly explained in the brief foreword "In Perspective". The sections not only describe the aims and methods of the company, thus providing the background to its rapid development, but review the wide range of standard and other products now manufactured and indicate, in some measure, the almost infinite variety of actual and potential applications of control equipment throughout industry.

Circle **98** *for further details.*

Quickfit Catalogue

New items in the 1961 catalogue, issued by Quickfit & Quartz Ltd. include an electrically-heated circulatory evaporator unit and automatic water stills. This 152 page catalogue is illustrated with numerous photographs and drawings and there is a comprehensive index.

Circle **99** *for further details.*

De Havilland Gazette

The April issue of the *De Havilland Gazette* contains a two page article on "Infra-Red Technology". Among the significant advances in the industrial field mentioned are the systems being developed to monitor the size, position, speed and temperature gradients of metal ingots in steel rolling mills and so regulate the even flow of the process. Long response time total radiation pyrometers are currently employed in many applications where short response time wave-length-sensitive systems, now under development, are expected to give much improved results.

Another article entitled "Nuclear Power in Flight" is also of interest.

Circle **100** *for further details.*

Meters

The full range of ring balance meters manufactured by Hagan Controls Ltd. for measuring and recording fuel flow is described and illustrated in a new brochure recently published. Diagrams showing suggested installation details are included.

Circle **101** *for further details.*

Norgren Accessories

Leaflet, Form No. Acc.6/60 describes and illustrates the accessories available for use on or with Norgren equipment and also points out the availability of repair and service kits which are especially valuable for maintaining units abroad or in a remote locality.

Circle **102** *for further details.*

Platinum Metals Review

The April issue of this journal published by Johnson, Matthey & Co. Ltd. includes the following articles:

"The Design of Light Duty Electrical Contacts, Economics of Manufacturing and Assembly Methods" by J. C. WANT.

"Precision Potentiometers for Artificial Horizons".

Circle **103** *for further details.*

Air-operated Receiving Instruments

Specification Sheet SS 010, February, 61 from George Kent Ltd., gives details of their Commander air-operated receiving instruments. These instruments are in general Bourdon-tube operated. A full specification and mounting details are included.

Circle **104** *for further details.*

Flow-measuring Instruments

Commander float-operated open-channel flow-measuring instruments are the subject of Specification Sheet SS 013 February 61, from George Kent Ltd. Specification together with some illustrations of typical instruments are shown.

Circle **105** *for further details.*

Engelhard Industries Ltd.

The December, 1960 overseas edition of Engelhard Industries, Inc. *Technical Bulletin* includes an article entitled "Multi-range, Volt-Ampere Standard for D.C. and Extended Frequency A.C. Measurements." This is designed to meet the increased need for functional, portable instruments capable of measuring d.c. and a.c. currents. Mention is made of the model "C" Hermach-Engelhard transfer voltmeter designed for this purpose.

Circle **106** *for further details.*

Widney-Dorlec Technical Furniture

A 10 page catalogue, Publication No. R/4002/5, illustrates instrument housings, controls, panels, etc. Abridged specification details are mentioned.

Circle **107** *for further details.*

Lubrication System

Dispensing units, which can be made up into assemblies having from 2 to 8 outlets are contained in an illustrated 12 page booklet entitled "Universal Centralised Lubrication Systems", obtainable from Castrol Industrial Ltd.

Circle **108** *for further details.*

Wiring Harness

Rist's Wires & Cables Ltd. have recently published a four-colour leaflet G61126 which deals with pre-formed wiring and illustrates a typical wiring harness and its applications. Special end connections are also illustrated.

Circle **109** *for further details.*

Electrical Resistance Furnaces

Johnson, Matthey have issued a revised and enlarged service of data sheets, the 1740 series, on their range of platinum-wound electrical resistance furnaces and control units.

The ash fusion and controlled atmosphere furnace, Type K45F is primarily intended for the determination of the fusion points of coal and coke ash by the method described in B.S. 1016: Part 15.

The control unit recommended for the K45F furnace is Type C8, which can be used with all other JMC furnaces except Type TK2.

In addition to the K45F furnace, the full range of JMC furnaces includes eight general-purpose furnaces with cylindrical combustion chambers and three with rectangular combustion chambers, for maximum operating temperatures of 1350-1500°C, and the TK2 thermocouple calibration furnace operating at up to 1775°C. The largest rectangular combustion chamber available in the range measures 12 × 6 × 5 in.

All furnaces are constructed with ample thermal insulation, so that they can be used on an unprotected bench top; all except the TK2 are supplied with platinum: rhodium-platinum thermocouples as standard.

Circle **110** *for further details.*

Arc Welding Electrodes

The British Electrical & Allied Manufacturers' Association have published a new and completely revised 100 page edition of their "Guide to Arc Welding Electrodes". This is the sixth edition of this publication and is designed to assist the user in the choice of suitable electrodes for each purpose. It gives, in a convenient form, classified lists of British electrodes and a key to American and British Electrode Standards, as well as a brief description published by the British Standards Institution as B.S.1719, 1951. The equivalent American method of classification and code numbers are also shown in all the classified lists.

A section is included which gives information on special electrodes and lists of the special electrodes available for welding non-ferrous metals, cast iron, corrosion resistant and other steels.

The guide is priced at 5/-.

Circle **111** *for further details.*

Radiation Protection Catalogue

A new catalogue of radiation protection materials, equipment and accessories of interest to industrial safety officers, radiographers and all concerned with gamma or X-rays, is now available from Research & Control Instruments Ltd.

Materials are listed suitable for every type of laboratory, production, or site work, and the advisory service offered by the firm is described.

Circle **112** *for further details.*

Asbestos

Asbestos in the Electrical Industry is a publication issued recently which deals with the range of Turner's asbestos products available and illustrates the many varied ways in which the electrical field is served by asbestos textiles.

Circle **113** *for further details.*

"Tickocraft"

The spring edition of *Tickocraft*, which is the quarterly house journal published by Tickopress Ltd., contains a review of progress in the design, production and use of labels, tickets, tags and marking devices.

Circle **114** *for further details.*

"Hilger & Watts News"

A special edition of *Hilger & Watts News*, published for the personnel of Hilger & Watts Ltd., has been issued to announce the inclusion of Wray (Optical Works) Ltd. in their group of companies. Extracts from the statement of the chairman to the shareholders for the year ending 1960 are included.

Circle **115** *for further details.*

Air Automation Catalogue

The range of products listed in this catalogue represents the result of a number of years of research, by Air Automation Ltd., into the problem of producing pneumatic equipment which will be completely reliable in use, and of moderate price. The products dealt with include air control valves and cylinders, pneumatic vices, blow guns and airline equipment. There are also details of a number of new lines, of particular interest being the $\frac{1}{2}$ in. bore air cylinders. A brief catalogue index is to be found on the back page.

Circle **116** *for further details.*

Products of the Holmes Organisation

Publication No. 88 available from W. C. Holmes & Co. Ltd. describes the range and scope of the products designed and manufactured by the company in the chemical engineering, gas handling and gas cleaning divisions.

Circle **117** *for further details.*

Dissolved Oxygen Analysing Meter

The Cambridge Instrument Co. have produced a new publication List 148/2 which describes their dissolved oxygen analysing meter. This instrument provides a continuous automatic analysis of boiler feed water in smaller power producing plants employing mechanical de-aerators.

The equipment described is not suitable where chemicals are added to feed water and the company's electrochemical analyser (List 323/3) is mentioned as being suitable for these conditions.

Ranges available on the dissolved oxygen analysing meter are 0-1, 0-0·5 and 0-0·25 cm^3/l dissolved oxygen in water. Dependent upon conditions, accuracy to be expected is $\pm 0{\cdot}005$ cm^3/l.

Circle **118** *for further details.*

Vapour Pressure Thermometers

An up-to-date eight page publication (List 25/1) describes the vapour pressure thermometers manufactured by the Cambridge Instrument Co. Details of standard instruments are provided and information is also given on a wide variety of modifications and accessories which may be supplied to suit individual applications and processes.

Circle **119** *for further details.*

Recording Counters

List 143/1 from the Cambridge Instrument Co. describes their recording counters which record the frequency, clock time, and duration of industrial processes or machine operations. The circular charts on which this information is traced also indicate, by default, periods when the machine or process is shut off. Single or multi-pen recorders, operated by either mains or battery, are available and combined counters and temperature or pressure recorders can be supplied.

Circle **120** *for further details.*

Instrumentation

This is a technical information bulletin issued quarterly by Marconi Instruments Ltd. The format of the March issue has been changed with the introduction of the larger page size and the contents of each issue are now printed on the front of the cover. The main technical content of the bulletin is unaltered and continues to deal with articles written by design engineers on new products recently introduced into the catalogue. There are also summaries in a number of languages of all the major articles.

Circle **121** *for further details.*

Coatings

Industrial maintenance coatings are the subject of the latest 55 page sales handbook issued by Camrex Paints Ltd. for all those concerned in the use and application of the company's surface coatings for the prevention of corrosion in industrial fields. Details are given of the various types of primers, undercoats, finishing coats and special coatings, together with many coloured illustrations. There is also an index and a table of coverage.

Circle **122** *for further details.*

"Export"

Export is the latest EMI publication and describes the company's efforts to increase export sales, and acquaints the reader with the latest electronic developments. Every article is printed in four languages on the opposite page—English, French, German and Spanish—and the publication is well illustrated.

Circle **123** *for further details.*

Londex Products

To celebrate their Silver Jubilee, Londex Ltd. have produced a 52 page data book showing the extension of the company's range of products from the initial manufacture of relays to complete automation plants, including controls of level, flow and pressure, using the latest methods including electronics.

Among the products described are relays, timers, photo-electric equipment and counters, fluid and gas controls together with a section on miscellaneous controls.

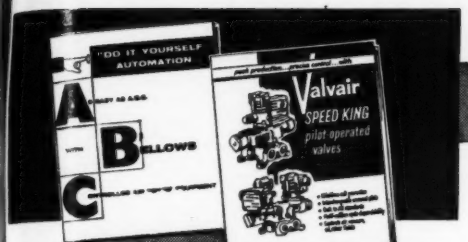
Circle **124** *for further details.*

Plastic Signs

Lamigraph Ltd. have recently issued a folder in connection with their laminated plastic signs. Among the literature included are stock lists of signs, and examples of road and British Railways signs.

Circle **125** *for further details.*

Circle 363 for further information



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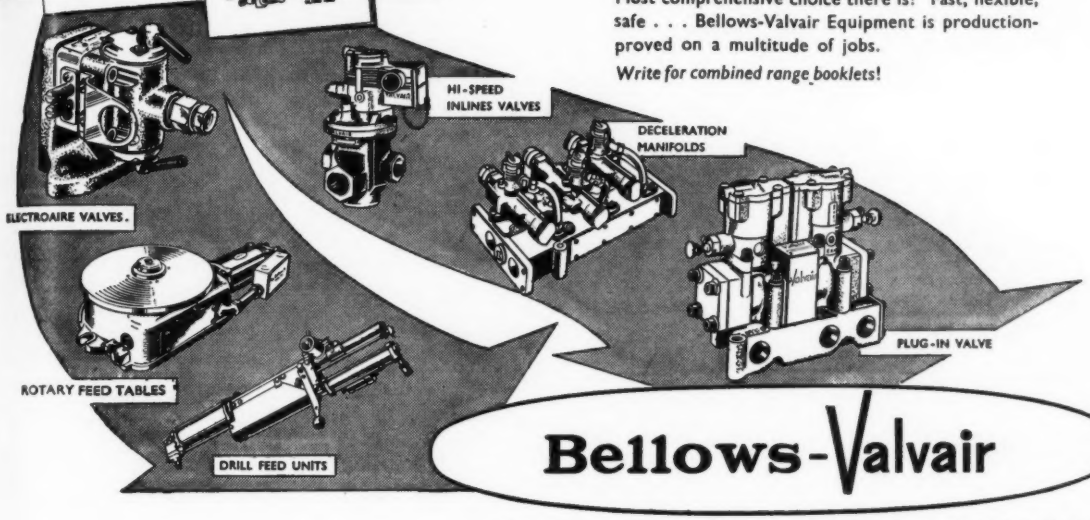

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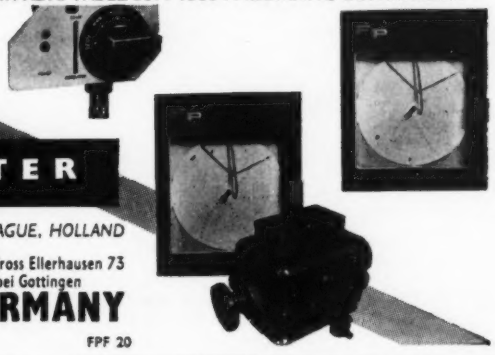

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Manufacturing Affiliates of Fischer & Porter Co., Warminster, Pa., U.S.A. FPF 20

Circle 364 for further information

Circle **365** for further information

Typical installation of the Altoflux Flowmeter for measuring flow of SO_2 liquor with dissolved salts.

Photograph by courtesy of the National Smelting Co. Ltd. Avonmouth, Bristol.

- Unrestricted flow, therefore no head loss ✱
- Accuracy to within ±1% of indicated reading ✱
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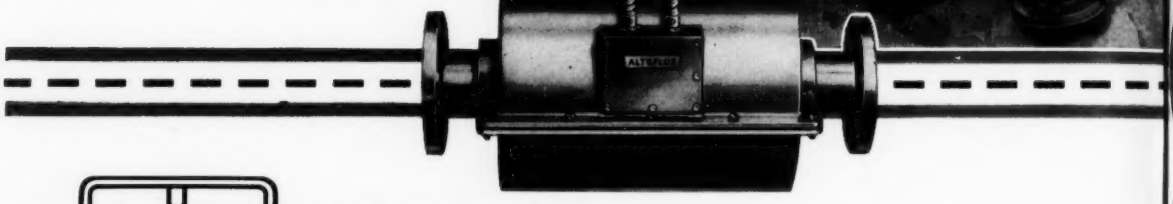

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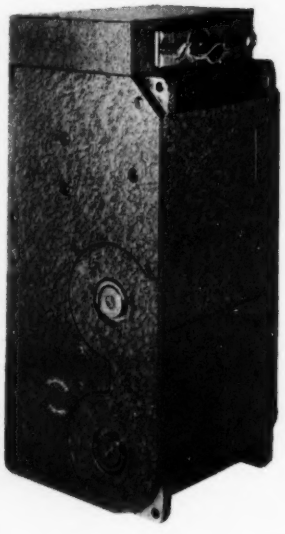

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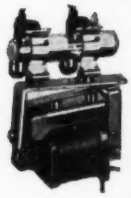

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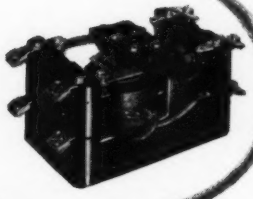
A small relay with moulded base and insulators. Contacts up to 3 amps. T.P.D.T. Coils up to 165v D.C. or 450v A.C.



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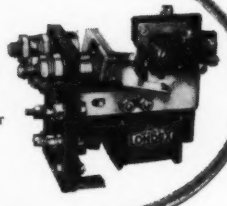

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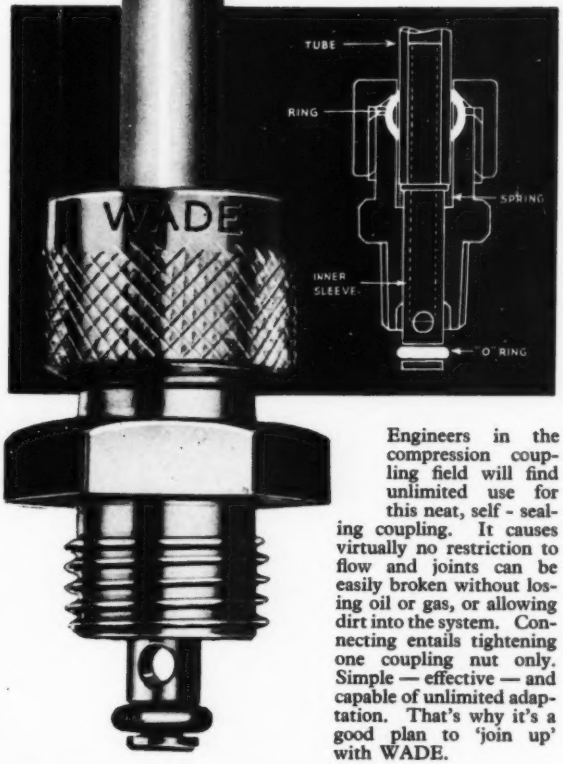

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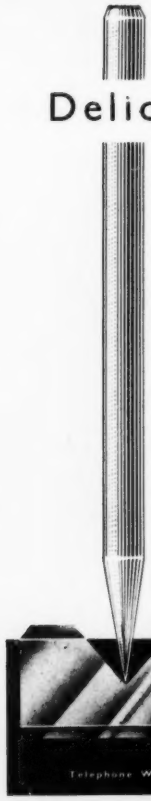

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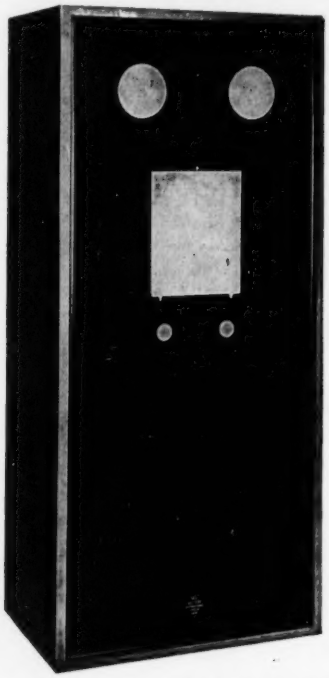

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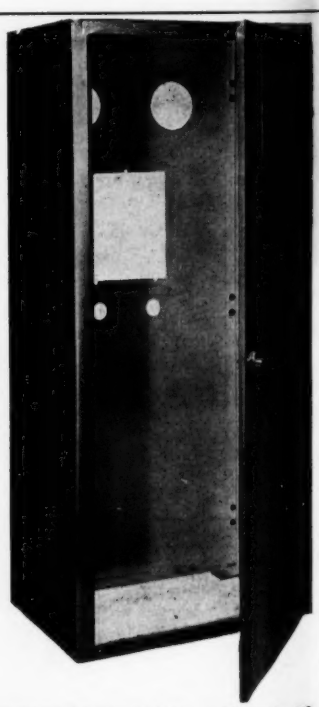

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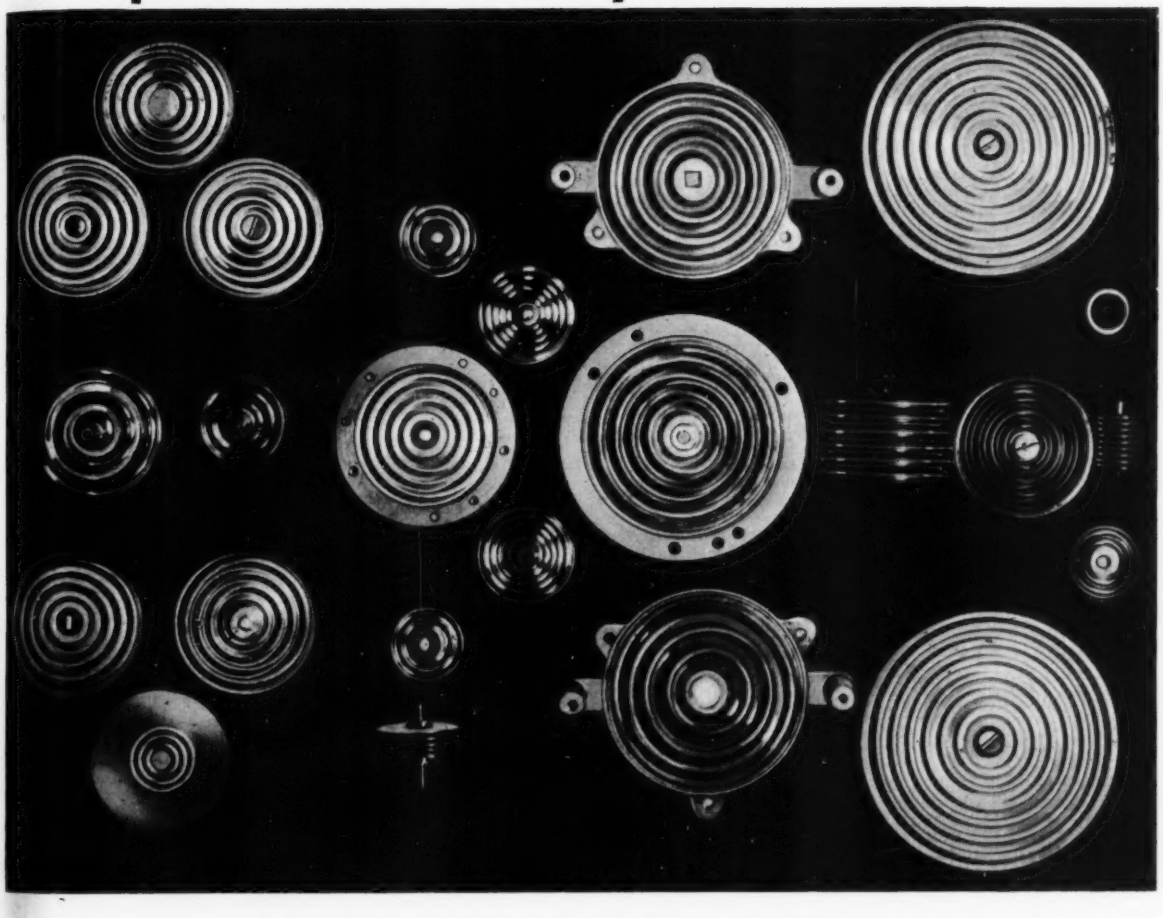

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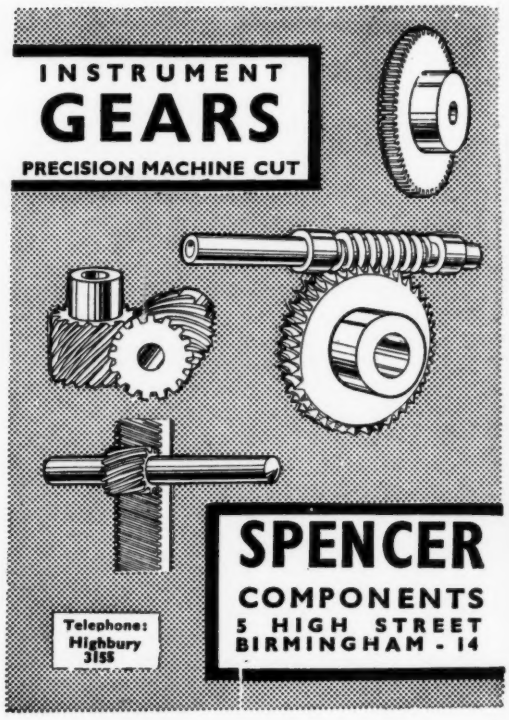

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This Course, which appeared originally as a serial in the technical journal, *Instrument Practice*, is the first of its kind to be published from British sources.

So great has been the demand for reprints of Mr. Miller's *Course in Industrial Instrument Technology* that the supply was soon exhausted, and a more convenient new edition, produced by the photolitho process, and bound in stout paper covers is now available.

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VII Flow Measurement: Integration from Differential Pressure Instruments.
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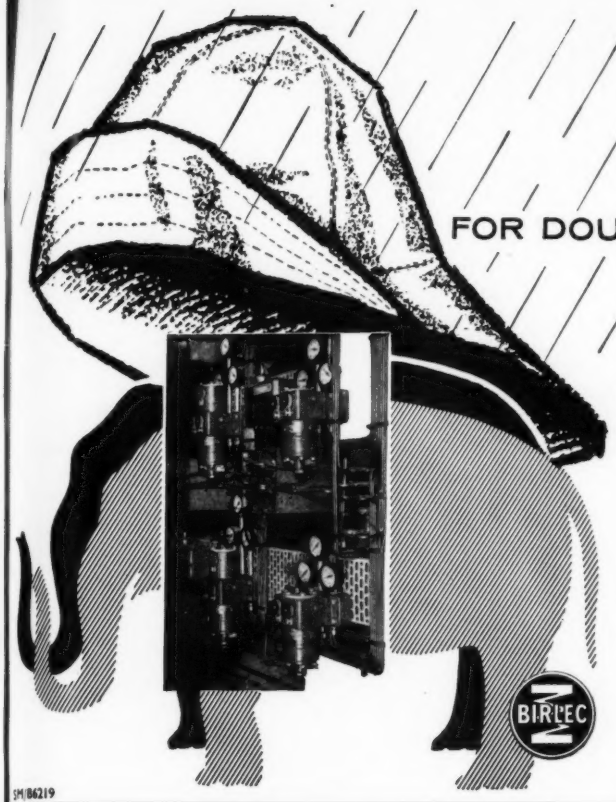

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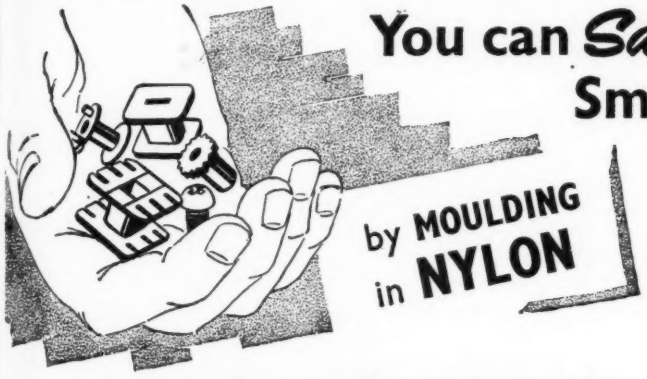

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The Proprietors reserve to themselves the right to refuse to insert an advertisement if they think proper to do so. All possible care is taken to ensure accuracy in setting up the advertisements, but should an error be made the Proprietors will not hold themselves responsible in any way for same.

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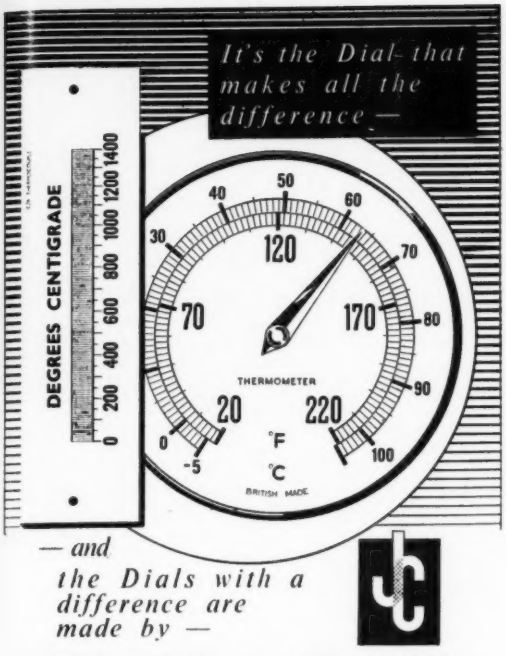
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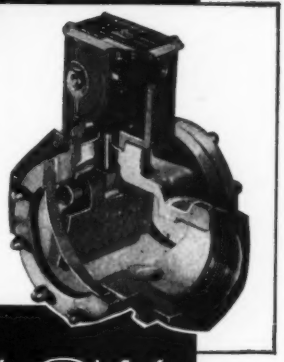

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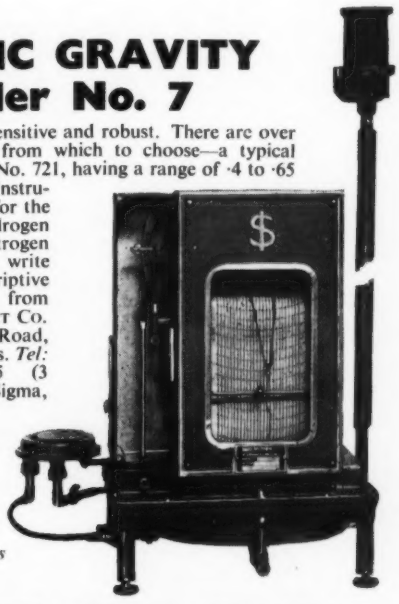

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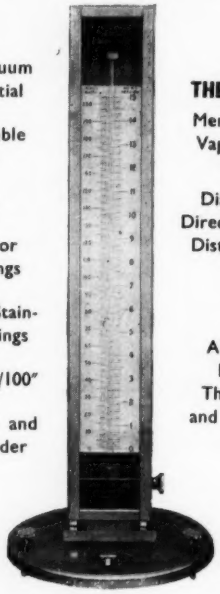

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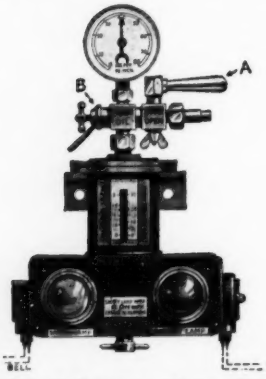

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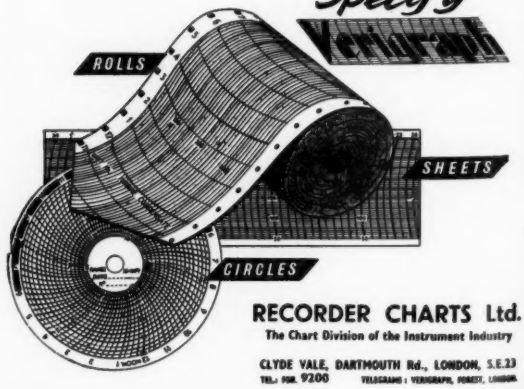

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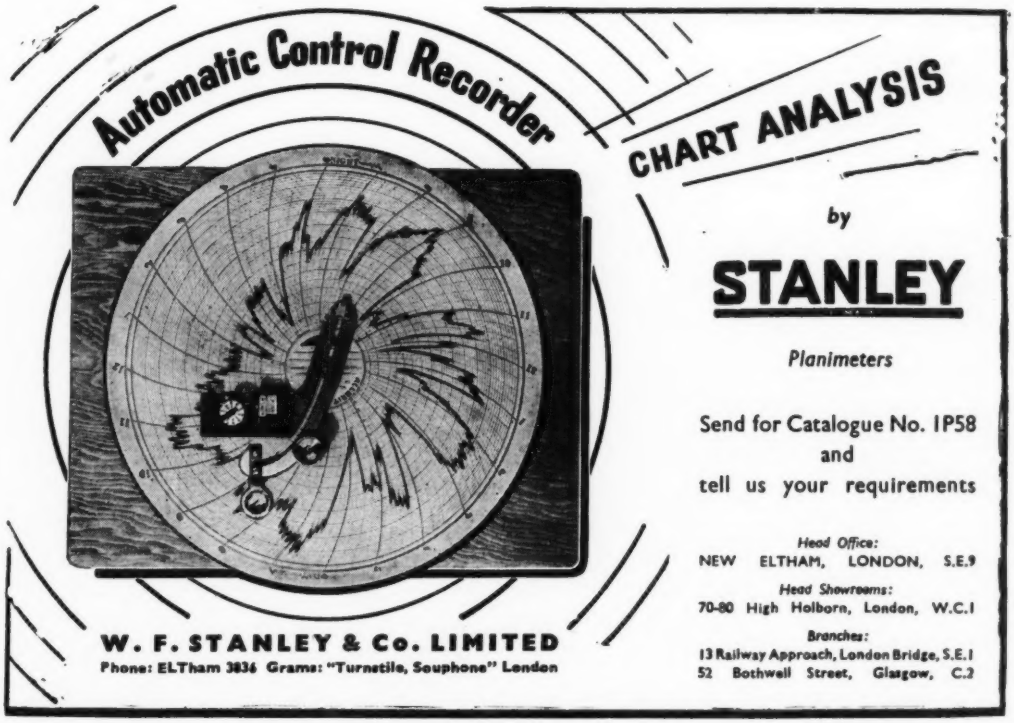

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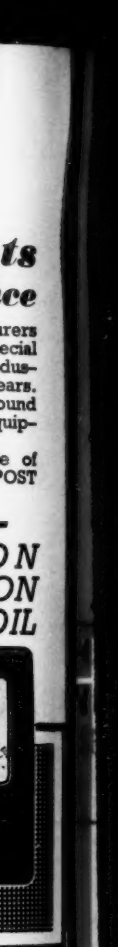

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